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No. 81

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NUCLEAR ENERGY

AES WATER-PURIFICATION SYSTEM CONTROLLED BY CHEMICAL MEANS

Moscow ENERGETIK in Russian No 8, Aug 81 pp 19-21

[Article by candidates of technical sciences S. A. Kuznetsova and V. I. Pashevich and engineers G. V. Yefimov, V. V. Maksimov and A. V. Dmitriyev: "Automatic System of Chemical Control of Chemical Water Purification at the Kol'skaya Power Station"]

[Text] Up until now, there has existed an approach for partially solving the problem of automating the chemical control of chemical water-purification systems, that is, the automated control of the operation of some certain filter or, correspondingly, of single-function filters has been examined. For the first time, an attempt has been made to develop a system of automatic chemical control of the entire chemical water-purification system at an AES.

The chemical water-purification installation at the Kol'skaya AES is designed to compensate for coolant losses in the first and second circuits of power-generating units with VVER-440 reactors. It consists of mechanical filters and a chemical desalinization unit. The design of the chemical water-purification system is based upon the principle of parallel connection of single-function filters.

The particular design features of the desalinization flow-diagram are associated with the quality of the raw water entering the chemical water-purification system. The raw water is characterized by an exceptionally low salt-content (20-25 mg/kg) and the stability of its composition. After passing through the mechanical filters, the water arrives at the clarified-water tanks (fig. 1) from which it is pumped through the hydrogen cation enchangers of the first stage into the decarbonizer tanks. The decarbonized water is pumped into the hydrogen cation exchangers of the second stage, then through the anion exchangers of the first stage which are filled with a strongly basic anion. The desalinized water is pumped into the make-up water of the reactor's second circuit.

A second characteristic feature of the chemical water-purification system associated with the quality of the raw water is the exceptionally long time duration of the filter cycles.

A third feature is the comparatively stable quality of the water during the processing stages. This simplifies considerably the task of automating the chemical control of the filters' operation.

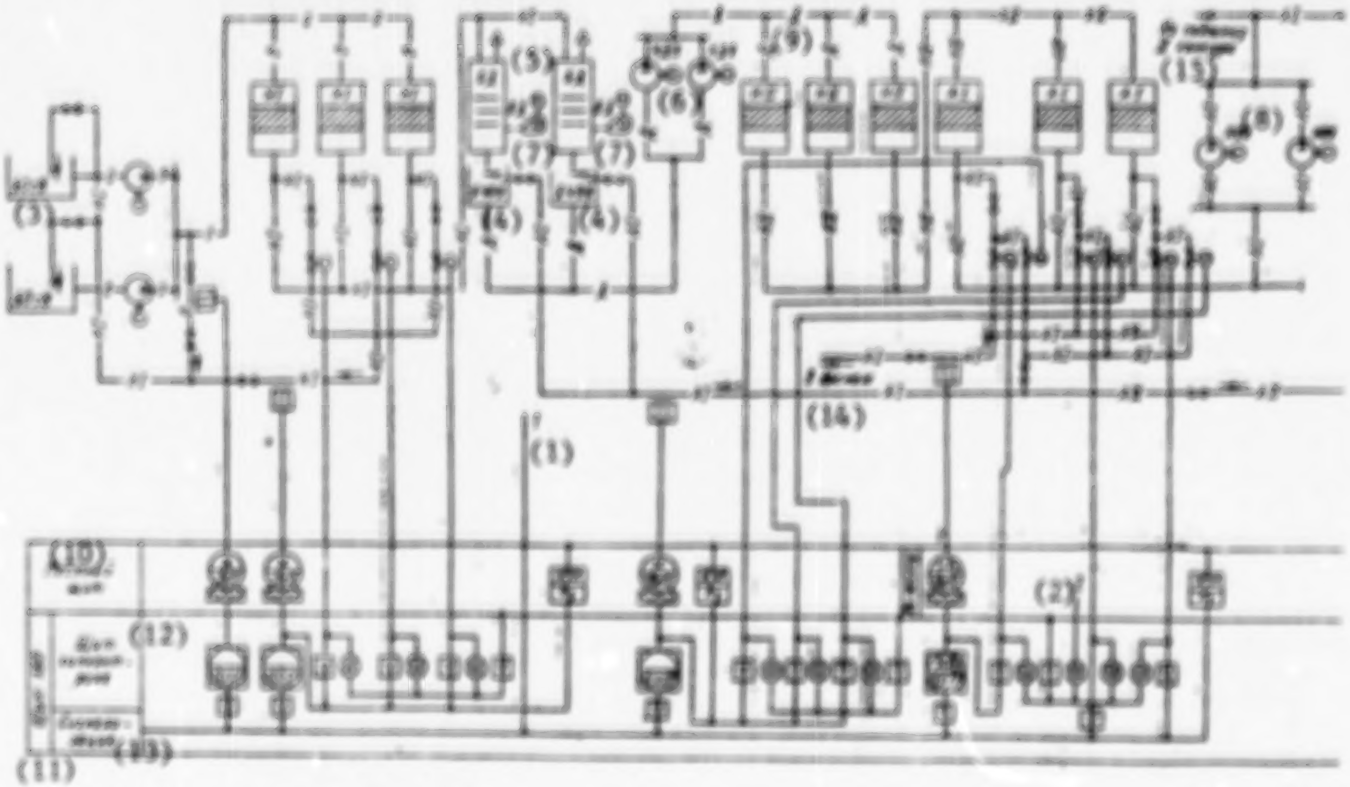

Figure 1. Basic Control Flow Chart

Key:

1. Lead-out to existing visual and audio signal devices
2. Analyzer's initial position
3. Clarified-water tank
4. Tank for partially desalinated water
5. Decarbonizer tank
6. Decarbonized-water pump
7. Decarbonizer fan
8. Desalinated-water pump
9. Decarbonized water
10. Local control panel
11. Chemical water-purification panel
12. Chemical control panel
13. Signal system
14. To drainage
15. To make-up water of second circuit

O. Clarified water
HI. Hydrogen-cationed water, first stage
HII. Hydrogen-cationed water, second stage
AI. Chemically desalinated water after first-stage anion exchangers

The selection of parameters for the automatic chemical control of the filters' operation always involves a study of the dynamics of change in the basic parameters which determine the quality of its filtrate. In accordance with the operating conditions adopted for the hydrogen cation exchanger of the first stage, the parameter controlling its operation is the filtrate acidity, the reduction of which as the filter wears out is determined by the breakthrough of sodium ions (Na^+) into the filtrate and is accompanied by a lessening in the specific electrical conductivity of the filtrate. The operation of the hydrogen cation exchanger of the first stage was controlled using the acidity (titration with a compound indicator), the content of sodium with the aid of a laboratory method to determine the Na^+ concentration by means of an ion-selective electrode (the pH-340 meter) and the specific electrical conductivity of the water at the filter's input and output as the most standard indicator. The specific electrical conductivity was measured with a portable conductivity apparatus having grade-1 accuracy, measurement ranges of $0.01-11 \cdot 10^3$ and $0.01-100 \cdot 10^4$ $\mu S/cm$, temperature compensation and two sensing elements with constants C equal to 1 cm^{-1} and 0.1 cm^{-1}.

The stability of the quality of the raw water is borne out by the nature of the variation in its specific electrical conductivity $\varkappa$ during the filter cycles for different filters (fig. 2,a). The mean statistical value for the water's specific electrical conductivity before filtration is 65 $\mu S/cm$ at the hydrogen cation exchanger of the first stage. The range of measuremnt for the value of $\varkappa$ for the filter cycles examined is 60-75 $\mu S/cm$. The range of measurement of the specific electrical conductivity of the filtrate after the hydrogen cation exchanger during its working cycle is equal to 130-100 $\mu S/cm$ with a mean statistical value of $\varkappa$ = 120 $\mu S/cm$

The Na^+ concentration in the filtrate is practically constant (∿50 $\mu g/kg$). Its greatest variations are associated with the inclusion of the filter in the operation after it had been put on standby while the decarbonizing tanks were filled. The depletion of the filter in accordance with the data obtained, characterized by an acidity variation of 180 μg-equivalent/kg, is accompanied by an acute fluctuation in the Na^+ concentration up to 6 mg/l and a reduction in the value of the specific electrical conductivity of up to 60 $\mu S/cm$.

In this manner, the two parameters Na^+ and $\varkappa$ can be treated as the parameters of the automatic chemical control. The application of an industrial sodium indicator for this purpose at Kol'skaya AES can hardly prove to be suitable because of the duration of the filter cycles, since the operation of sodium-concentration measurement devices involves the necessity of preparing and utilizing analytically pure NH_4OH for maintaining the pH level necessary for measurement and calibration. In other words, the expenditures associated with servicing the device can exceed the economic gain derived from its utilization.

The feasibility of utilizing the specific electrical conductivity of the filtrate as a parameter for automatic chemical control is supported by the nature of the fluctuation during the filter cycle (fig. 2,a) which demonstrates the stability of the value $\varkappa$ during the working cycle. The maximum deviation from the mean statistical value of $\varkappa$ is 16 percent, while the figure is 50 percent when the filter is spent. The absolute value of the specific electrical conductivity when the filtrate acidity varies by 180 μg-equivalent/kg is 60 $\mu S/cm$.

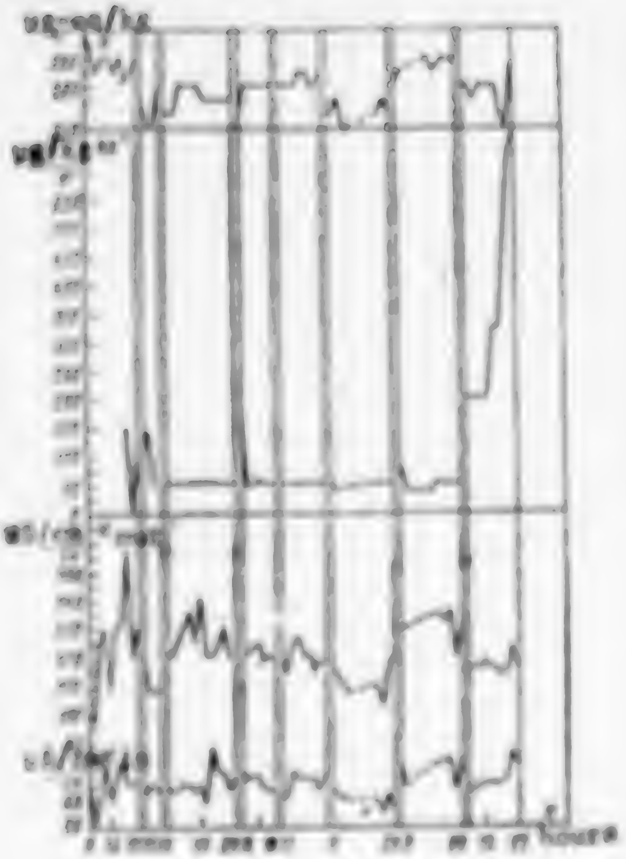

Figure 2. Fluctuation in the Quality Indicators for the Filtrate from the Hydrogen-Cation Exchangers of the First (a) and Second (b) Stages

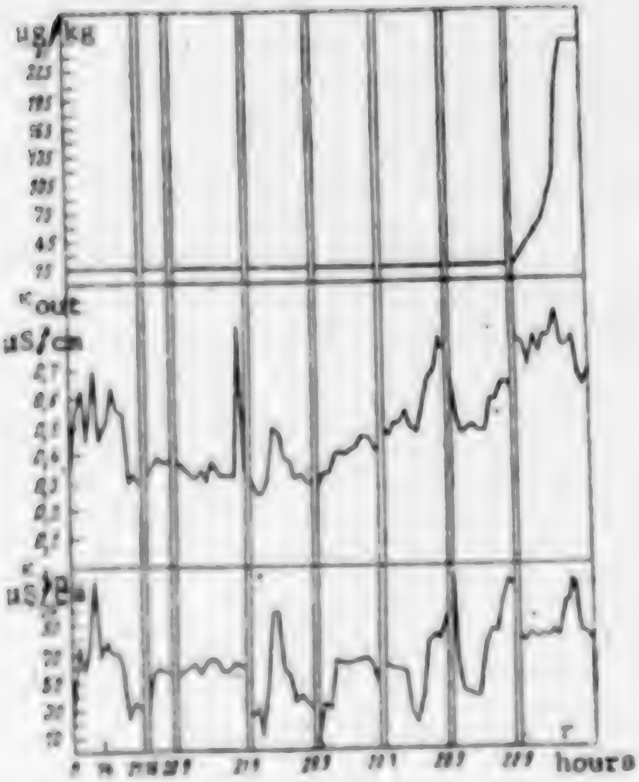

Figure 3. Fluctuation in the Quality Indicators for the Filtrate from the Anion Exchanger of the Second Stage

The simplicity, reliability, ease of servicing and specificity of the established parameter as a standard indicator of the quality of the treated water make it possible to use the conductivity-measuring device not only as a signalling device for filter depletion but also as a continuous-operation instrument which provides information on any change in the filtrate quality (emergency situations, inleakage, etc.).

The operation of the hydrogen cation exchanger in the second stage was controlled with respect to acidity and specific electrical conductivity. In contrast to the majority of flow diagrams, the hydrogen cation exchanger in the second stage of the Kol'skaya AES is disconnected when the filtrate acidity drops. The instability of the filtrate quality after the hydrogen cation exchangers of the second stage (fig. 2,b), expressed in the considerable fluctuation of specific electrical conductivity (from 10 to 120 μS/cm) and acidity (from 30 to 260 μg-equivalent/g), can be explained by the operating mode of the water-purification system.

Depending upon the ratio of decarbonized water to the desalinized water arriving at the inlet of the decarbonized-water pumps through the recirculation line, fluctuations occur in the filtrate quality before and after the second stage. There are fluctuations in all the indicators except Na^+.

The broad range of fluctuation in the filtrate quality with respect to specific electrical conductivity after the hydrogen cation exchanger of the second stage makes it impossible to establish automatic control over the filter's operation with respect to this parameter. However, the design features and the operation of the flow diagram of the chemical purification system of the Kol'skaya AES (disconnection of the second-stage hydrogen cation exchanger when the Na^+ concentration breaks through; charging of the next filter AI with a highly basic anionite) makes it possible to utilize a new method of control over the depletion of the hydrogen cation exchanger. The method consists of registering the depletion of the cation exchanger by using the increase in the specific electrical conductivity of the filtrate from the highly basic anion exchanger. This increase is brought about by the formation of a highly dissociated base in accordance with the exchange reactions

$$R^+|OH^- + Na^+|Cl^- \rightarrow R^+|Cl^- + Na^+|OH^- ,$$

that is, up to the appearance of the hydroxyl ion in the filtrate in a concentration equivalent to the Na^+ concentration.

In the process, the conductivity meter installed after the first-stage anion exchanger fulfills two functions: it is a signal device for the depletion of the hydrogen cation exchanger of the second stage and an instrument which continuously monitors the quality of the desalinated water used as make-up water in the second circuit.

In this case, fluctuations in the quality of the filtrate from the hydrogen cation exchanger of the second stage do not affect the disconnect signal (fig. 3) since the range of fluctuation x in the filtrate from the anion exchanger amounts to 0.25–0.9 μS/cm with a mean statistical value of $x = 0.35$ μS/cm. At the same time, the value x with an increase in the salt content of up to 1–2 mg/kg as allowed by standards and caused by the breakthrough of Na^+ after the hydrogen cation exchanger will be equal to 2-4 μS/cm. It has been suggested that the silicon content be employed as a parameter for the automatic chemical control over the operation of the highly basic anion exchanger. The silicon content is at present the only monitoring indicator of the operation of the highly basic anion exchanger.

Thus, the system for the automatic chemical control of the chemical water-purification system at the Kol'skaya AES provides for the automatic control of the filtrate quality after each stage of water treatment (fig. 1).

One design feature of the chemical control scheme is the installation of one filtrate-quality analyzer for the entire group of single-function filters with programmed switching of the test from each filter with the aid of an electrohydraulic relay. Such a solution, having great economic advantages, is feasible and justified for the given layout because of the duration of the filter cycles and the lengthiness of the regeneration yield (fig. 2,3). This excludes the simultaneous regeneration yield of single-function filters.

The measurement cycle at a single filter can be varied from 5 to 15 minutes with the aid of a time relay. Automatic control of the operation of the first-stage hydrogen cation exchangers is accomplished by means of direct measurement of the specific electrical conductivity using a KS-211 conductivity-measuring device. The regeneration yield of the second-stage hydrogen cation exchanger is automatically monitored with the AK-310 conductivity-measuring device.

The automatic disconnection of the first-stage anion exchanger for regeneration is accomplished with the AV-211 silicon analyzer. Provisions have been made for the continuous measurement of the input water's specific electrical conductivity at the collective main, as the water enters the purification system. This makes it possible to give an inferred evaluation of the control over the measurement of the input-water quality. In case it becomes necessary, it also makes it possible to carry out the corresponding correction in the value of x, by which the hydrogen cation exchanger in the first stage is disconnected for regeneration.

Conclusions

1. On the basis of the research that has been conducted on selecting the parameters for the automatic chemical control of the operation of filters in the chemical water-purification system at the Kol'skaya AES, a system has been suggested for the automatic chemical control of the quality of the treated water after each stage of treatment.

2. An arrangement has been recommended for chemical control using one sensor element to measure the filtrate quality after all single-function filters.

3. A conductivity-measurement method has been proposed for controlling the operation of the hydrogen cation exchanger in the first stage.

4. It is suggested that a single device be used--a signalling instrument of the conductivity-measurement type--to monitor the depletion of the hydrogen cation exchanger in the second stage and to monitor simultaneously the quality of the desalinated water used for make-up in the second circuit.

5. The depletion of the highly basic anion exchanger is automatically monitored by the silicon-content analyzer.

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UDC 621.039.58

BUILDUP OF RADIOACTIVE CORROSION PRODUCTS IN TECHNOLOGICAL EQUIPMENT OF NUCLEAR POWER PLANT COOLING SYSTEMS

Moscow ATOMNAYA ENERGIYA in Russian Vol 51, No 1, Jul 81
(manuscript received 29 Oct 80) pp 54-55

DOLGOV, V. M. and KATANAYEV, A. O.

[Abstract] A method of determining the buildup of radionuclides on the surfaces of the cooling system equipment in a nuclear power plant has been developed which involves measuring the concentration of each radionuclide in the coolant at the inlet and at the outlet, with these concentrations maintained constant during the measurement. For each radionuclide the rate of change of its number of atoms deposited on a surface is equal to the difference between the effect of mass transfer from the coolant to the surface (concentration drop from inlet to outlet multiplied by the mass flow rate of coolant) and the effect of its disintegration at the surface (rate of disintegration proportional to the number of existing atoms). Consequently, the number of radionuclide atoms built up consists of a linearly increasing part and an exponentially decreasing part. The method has been tested experimentally in a special bypass to the main N_2O_4 loop of a cooling system. Samples of deposits of corrosion products built up over a period of 20 days were examined with a gamma-spectrometer containing a Ge(Li) detector and an LP-4840 analyzer, and the principal sources of gamma-radiation were found to be Cr^{51}, Co^{58}, Mn^{54}, Fe^{59} and Co^{60}. It has been assumed that the activity of these radionuclides in the coolant remains constant over the test period, which is entirely valid only for radionuclides with a sufficiently long half-life, and that disintegration of these radionuclides during sampling is negligible. Accordingly, the readings after a long buildup test time will have some error. This error is largest for Cr^{51} and successively smaller for Fe^{59}, Co^{58}, Mn^{54} and Co^{60}. Figures 2, table 1, references 5 Russian.
[214-2415]

UDC 621.09.54.539.128.4.144:539.166.3

COMPLETE ANALYSIS OF DEPLETED FUEL IN ATOMIC ELECTRIC POWER PLANT WITH 440 MW WATER-COOLED WATER MODERATED POWER REACTOR

Moscow ATOMNAYA ENERGIYA in Russian Vol 51, No 1, Jul 81
(manuscript received 9 Feb 81) pp 53-54

ZELENKOV, A. G., PIROZHKOV, S. V., PCHELIN, V. A., RODIONOV, Yu. F., TARASEVICH, V. P., SINYUTINA, Z. M., CHISTYAKOV, L. V., SHATINSKIY, V. M., SHVETSOV, I. K., SHUBKO, V. M. and BARANOV, S. A.

[Abstract] A complete radiochemical, radiometric and mass-spectrometric analysis was done on the depleted fuel of the fourth unit of the Novoronezhskaya atomic electric power plant, for the purpose of checking out the reactor operation program

and predicting the performance of isotopes of transuranium elements in the 440 MW water-cooled water-moderated reactors at burnup of 33.2 kg/ton. A specimen of the fuel element material weighing 8 g was taken from the central part of the container. Altogether 20 heavy nuclides, from U^{232} to Cm^{246}, were determined quantitatively. The burnup of fission products Nd^{148} and Cs^{137} was measured more precisely and found to be 33.4 ± 1.2 kg/ton. The other nuclides include U^{232}-U^{238}, Pu^{236}-Pu^{242}, Am^{241}-Am^{243}, Cm^{242}-Cm^{246} and the final readings on their relative content take into account disintegration of Pu^{236} to U^{232}, of Pu^{241} to Am^{241}, and Cm^{242} to Pu^{232} as a function of time. The authors thank V. M. Semochkin and V. A. Denisov for assisting with the radiochemical analysis, also V. S. Shiryayev, N. I. Aleshin and L. N. Morozov for performing the measurements. Table 1; references 9: 5 Russian, 4 Western.
[214-2415]

UDC 621.039.003

EFFICIENCY AND ECONOMY OF PROSPECTIVE TYPES OF CIRCULATORS FOR WATER-GRAPHITE REACTORS

Moscow ATOMNAYA ENERGIYA in Russian Vol 51, No 1, Jul 81
(manuscript received 26 Jun 80, after final revision 12 Dec 80) pp 9-12

KARASEV, E. K., SMIRNOV, V. G., KON'KOV, Yu. V., VAZINGER, V. V. and TRUBKIN, Ye. I.

[Abstract] The coolant in water-graphite channel reactors is usually circulated by electric pumps, but such pumps do not always provide the optimum solution to the problem. Alternatives that have been considered are turbopumps and heat pumps, specifically jet-type heat pumps. A comparative evaluation of these types of circulation pumps is made in terms of efficiency and economy, including the cost of partial or total replacement of electric pumps in the 2400 MW RBMKP reactor. The sectional construction of this reactor calls for many smaller pumps with smaller-diameter piping, which ensures a better reliability. The advantage of turbopumps is that they are driven by the steam generated in the evaporator, but steam and water must be strictly separated here. The advantage of heat pumps is that they do not require strict separation of water and steam, saturated water being expanded into a two-phase stream with high kinetic energy and the flow rate of saturated water remaining constant at given pressure or temperature. Preliminary calculations indicate that with heat pumps instead of electric pumps the amount of metal needed for constructing the circulation system is reduced to less than one fifteenth, while the cost of coolant circulation is reduced to one third. Figures 3, tables 3, references 2: 1 Russian, 1 Western.
[214-2415]

UDC 621.039.55

FLASK EQUIPMENT FOR IRRADIATING STRUCTURAL AND ABSORBENT MATERIALS IN N_2O_4 DISSOCIATING COOLANT OF 'MARIA' REACTOR IN POLAND

Minsk IZVESTIYA AKADEMII NAUK BSSR: SERIYA FIZIKO-ENERGETICHESKIKH NAUK in Russian No 3, Jul-Sep 81 (manuscript received 22 Sep 80) pp 31-34

GOL'TSEV, V. P., KARPENKO, G. D., NESTERENKO, V. B., SIDORENKO, G. G. and FEDYUSHIN, Ye. Ye., Institute of Nuclear Power Engineering, BSSR Academy of Sciences

[Abstract] A test stand has been designed and built at the Institute of Nuclear Power Engineering (BSSR Academy of Sciences) for studying the behavior of structural and absorbent materials in N_2O_4 dissociating coolant under conditions corresponding to those in the "Maria" reactor in Poland. The equipment is of the vertical flask type, with extra features including facilities for natural circulation in a closed loop, for regulating the temperature of the materials (573-973 K) as well as the pressure (up to 16.0 MPa) and the chemical composition of the coolant, and for simultaneous testing in two or more channels. Inside each flask there is a Field tube providing coaxial paths for descending and ascending flow, and a protective plug reaching from the top deep down the wider upper part which constitutes the cooling zone. Specimens of a material are placed under the plug in the narrower lower part constituting the zone of heat generation and surrounded by a protective jacket, with helium or nitrogen injected through a movable surge tank for respectively either lowering or raising the thermal resistance to heat transfer from the specimens of a material to the reactor water. The channel equipment includes, in addition to a pair of flasks with a supply tank for each, also a transfer tank and a neutralizer, as well as a vacuum pump and a tank for the nitrogen of the nitrogen tetroxide, a helium tank and a nitrogen tank for regulating the thermal resistance, all with the necessary piping and valves. The nominal flow rate of the coolant is 10 g/s, at which 10 kW of thermal power can be dissipated from a specimen of a test material. Figures 2, references 7 Russian.
[212-2415]

UDC 621.039.526

CALCULATING NEUTRON-PHYSICAL CHARACTERISTICS OF FAST REACTOR TO OPTIMIZE ATOMIC ELECTRIC POWER PLANT

Minsk IZVESTIYA AKADEMII NAUK BSSR: SERIYA FIZIKO-ENERGETICHESKIKH NAUK in Russian No 3, Jul-Sep 81 (manuscript received 23 Aug 80) pp 10-14

USYNIN, G. B., CHIRKOV, V. A. and ZBRUYEVA, S. V., Gor'kiy Polytechnic Institute imeni A. A. Zhdanov

[Abstract] The neutron-physical characteristics of a fast multiisotope reactor with several different heat carriers depend on the fuel composition within the various reactor zones and they determine the performance of an atomic electric power plant with such a reactor. Here the steady fuel cycle is calculated, assuming equal constant amounts of plutonium bred in the reactor and fed to the reactor. The concentration of each isotope at some point within the reactor space at some instant of time is calculated from the equation of fuel depletion, taking into account that the cross sections for isotope capture and fission vary along the radius in a reactor with intricate fuel enrichment and reloading arrangement. The problem with distributed parameters and an arbitrary radial variation of the cross sections is reduced to integration with respect to six variables in a problem with lumped parameters. There follows the selection of the radial distributions of heavy atoms concentration and of relative fuel enrichment which will be optimum with respect to criticality and excess fuel breeding. The calculations include also the rate of buildup of the number of reactors working in the intrinsic fuel mode. The computer calculation flow diagram for optimizing the reactor design with respect to neutron-physical characteristics is applicable to such reactors as the BN-350. Figure 1, references 3 Russian.
[212-2415]

UDC 621.311.25+621.039.52

METHOD OF DISTRIBUTING NUCLEAR FUEL REGENERATION COST

Minsk IZVESTIYA AKADEMII NAUK BSSR: SERIYA FIZIKO-ENERGETICHESKIKH NAUK in Russian No 3, Jul-Sep 81 (manuscript received 10 Nov 80) pp 5-9

BYKOV, A. I., Institute of Nuclear Power Engineering, BSSR Academy of Sciences

[Abstract] Nuclear fuel is, after irradiation and subsequent soaking, reprocessed chemically for the extraction of residual uranium as well as accumulated plutonium and neptunium. The economic indicator of this reprocessing is the difference between the worth of the extracted product and the cost of chemical processing. Here this cost is analyzed, namely its distribution with respect to components of the production process. The cost distribution depends on whether plutonium or uranium and neptunium, or all three are the principal product. In each case the cost of

extraction will be affected by the isotope content in the irradiated fuel and the inevitable loss of the sought material during reprocessing. The coefficient in the expression for the extraction cost includes the "equivalent depletion factor" and a correction factor for the quality of extracted material, also the 93% U^{235} enrichment factor and the uranium content in the fuel. An evaluation of the various parameters in the cost equation indicates that extraction of plutonium from fuel elements in a thermal reactor is profitable as long as the cost of chemical reprocessing does not exceed 200 dollars/kg of fuel. As accumulated slag builds up from 14 to 42 kg/ton, the acceptable cost of chemical reprocessing increases to 300 dollars/kg. Chemical reprocessing of fuel from the thermal reactors at any cost within this range makes the subsequent use of extracted plutonium in fast reactors profitable. Chemical reprocessing of fuel from fast reactors is also profitable at any cost within this range, inasmuch as the cost of plutonium in this case is only one third the cost of plutonium extracted by reprocessing of fuel from thermal reactors. Figure 1, table 1, references 6: 4 Russian, 2 Western.
[212-2415]

UDC 629.12.03-83.001.63

SELECTING GENERATING SETS OF MARINE ELECTRIC POWER PLANTS

Leningrad SUDOSTROYENIYE in Russian No 6, Jun 81 p 38

SEMENENOK, A. F. and MAKSIMOV, V. A.

[Abstract] The problem of selecting the optimum structure of marine electric power plants is discussed, with the main focus on selecting variants of the structure of generating sets. This is a process which has all too often been carried out intuitively. A demonstration is given of the advantages of employing a computer for the purpose of statistical modeling of loads, the results of which form the basis for selecting variants of generating sets. Loads were determined for seven operating modes of electric power plants. A specific number of discrete power values was chosen for each power consumer with the corresponding values of the probability that the power values used would not be exceeded in the operating mode. Using input data of this sort made it possible to simplify the statistical modeling process, to shorten the time required for preparing input data and to obtain results with sufficient accuracy. Acceptable variants for outfitting power plants with generating sets of the standard series were first determined and then the final selection of sets was made from the results of analyzing these variants and by applying various criteria. The list of generating sets from which the algorithm selects variants for outfitting the power plant is determined by the nominal values of the power of sets of a standard series, each of which makes it possible to some extent to supply power consumers in the mode with the lowest load. If powers which are multiples of the nominal power of one generator from this list do not make it possible to supply consumers in the remaining modes, the algorithm searches for a new variant of outfitting sets for the following mode with regard to extent of loading. The output data of the outfitting problem include variants for the structure of generating sets recommended for installation on a vessel and operating in each mode specified, the utilization in these modes, and the composition of standby sets. Different variants are compared and evaluated by the following criteria: the minimum number of operating sets with the guaranteed supply of power to individual consumers; optimality of the load range in long-duration operating modes; minimum weight of generating sets; the possibility of the most heavy consumers starting up in a mode; and the effectiveness of the utilization of equipment. Employing the algorithm for making a calculation determination of the structure of generating sets with a computer in combination with the statistical modeling of loads gives more reliable results than does the intuitive empirical method. References 3 Russian. [203-8831]

UDC [538.12:518.5].001

CALCULATION MODELS OF POTENTIAL FIELD SOURCES FOR MHD GENERATOR WINDINGS

Moscow IZVESTIYA AKADEMII NAUK SSSR: ENERGETIKA I TRANSPORT in Russian No 2, Mar-Apr 81(manuscript received 15 Oct 79, after revision 28 Feb 80) pp 98-105

BORONIN, V. N. and VINOKUROV, M. R., Leningrad

[Abstract] A discussion is presented of variants of calculation models of saddle-shaped windings which make it possible to simplify the problem of modeling and calculating the three-dimensional magnetic field on a computer. This is accomplished by representing regions with current as surface magnetic charges. A method is suggested for constructing calculation models of regions with sources which makes it possible to make a more precise determination of the magnetic field in regions with current and of electromagnetic forces acting on elements of windings. The three-dimensional magnetic field of a saddle-shaped winding is studied not in relation to field vectors but in relation to the scalar magnetic potential function. The eddy magnetic field is reduced to the potential field of sources. For this purpose an additional field vector, H_0, is introduced, which obeys the sole condition curl $H_0 = \delta$. The volume and surface density of fictitious magnetic charges are determined from the equations $\rho_m = -\mathrm{div}\ \mu H_0$ and $\sigma_m = -\mathrm{div}\ \mu H_0$, where μ is the magnetic permeability of the medium. Two calculation model variants are presented which can be used both for calculating and modeling the magnetic field of saddle-shaped windings. The procedure of assigning potential field sources and measurements in a three-dimensional model can be simplifed substantially by employing a special-purpose mathematical model - computer computing complex, which makes it possible to automate the process of assigning sources in the model, obtain source data and enter it into the computer through communications channels and exchange data between the computer and model. This complex has been developed for the purpose of solving problems of electromagnetic field theory. Figures 4, references 6 Russian.
[198-8831]

UDC 621.313:537.312

REGULATING A SUPERCONDUCTING SYNCHRONOUS GENERATOR

Moscow IZVESTIYA AKADEMII NAUK SSSR: ENERGETIKA I TRANSPORT in Russian No 2, Mar-Apr 81 (manuscript received 22 Oct 79) pp 67-71

ILYUSHIN, K. V. and MIRONOV, O. M., Moscow

[Abstract] A solution is found to the problem of determining the maximum possible rate of current regulation in the field structure of a synchronous generator with superconducting excitation coils (an SPG). The basic material used at the present time for making superconducting systems is an Nb-Ti alloy and this material is susceptible to degradation with a change in magnetic field. There must be a fairly

rapid change in current in the superconducting winding and this requirement introduces added difficulties in implementing the excitation system. Increasing the exciter's power and the rate of current input can result in a considerable concentration of magnetic flux between the shield and winding. The problem is solved by finding the distribution of the magnetic field in a shielded multiterminal system. Electrodynamic characteristics are calculated by employing a two-dimensional mathematical model of an SPC with the generally accepted assumptions. The presence of electrically conducting shields is taken into account by means of two layers of current whose possible position is illustrated. The permissible rate of current input and the critical current under static conditions are taken into account. A critical current margin is taken into account, which is necessary because of the effect of degradation of the superconducting cable. A determination is made of the magnetic fields under any dynamic conditions of the system illustrated. An equation is derived which makes it possible to determine the voltage at the winding's terminals which must be applied for the purpose of realizing the type of regulation required, and two equations make it possible to find the distribution of eddy currents in the electrically conducting shields and of the magnetic fields caused by them. The condition is given which must be satisfied by the magnetic induction at the most heavily stressed point of the superconducting winding at any moment of time. An empirical dependence is found which makes it possible to take into account the dynamic properties of the superconductor. Equations are found which make it possible to determine the coordinates of the most heavily stressed point in the region occupied by the superconductor and the critical parameters at this point. The state of a shielded superconducting field structure can be estimated at any moment of time by comparing the value of the real current flowing through the winding with the critical. This problem was solved by means of a computer. Results obtained for a calculation model are presented. By means of the procedure suggested it is possible, knowing the level of current in the field structure, to calculate the minimum regulation time with which the superconducting state of the winding is maintained. The maximum magnetic field gradients over time take place at points located on the outer radius of the field structure. Figures 4, references 5: 2 Russian, 3 Western.
[198-8831]

UDC [621.313.322-81.3.013 : 537.312.62]001.24

FORCES AND STRESSES IN CRYOGENIC TURBINE GENERATOR ROTOR DURING SHORT CIRCUITING

Moscow IZVESTIYA AKADEMII NAUK SSSR: ENERGETIKA I TRANSPORT in Russian No 2, Mar-Apr 81 (manuscript received 24 Mar 80) pp 57-66

KOVARSKIY, M. Ye., RUBINRAUT, A. M. and TSYRLIN, A. L., Moscow

[Abstract] Sudden three-phase short-circuiting of the stator's winding is the most serious accidental situation which a cryogenic turbine generator must withstand without suffering damage. Questions relating to the strength of a cryogenic turbine generator are discussed, taking into account the interaction of the radial and tangential components of electrodynamic forces. An analysis is made of both the

space and time distribution of electrodynamic forces and mechanical stresses in the process of sudden short circuiting. A distinctive design feature of this kind of generator is that there is no massive ferromagnetic core for the rotor, but the superconducting excitation coil is enclosed in a number of coaxial cylindrical shells which play the role of an electromagnetic shield, a mechanical shroud and a heat shield. Eddy currents are induced in these shells in transient processes. The electromechanical processes which take place in the shells of the rotor of a cryogenic turbine generator with a revolving cryostat are discussed. In the process of short circuiting, in addition to the shock moment, radial and tangential forces originate whose influence on the rotor's strength can prove to be quite considerable and even decisive. The influence of tangential forces has not been taken into account in previous studies. Calculation diagrams are shown of the forces acting on the wall of a two-terminal cryogenic turbine generator during interaction of the magnetic field of the superconducting excitation coil and the field of the armature winding with the current in the wall induced by the armature's reactive current. The flow of capacitive current in the armature is accompanied by the greatest electrodynamic forces and mechanical stresses. A determination is made of the kinds of current flowing in the machine in short circuiting, whereby equations for the machine are written in fixed coordinates in relation to the superconducting excitation coil. A calculation is then made of electrodynamic forces on the shields. A calculation is made of the mechanical stresses originating in the cylindrical shields during short circuiting. Stresses in the shields are estimated by solving the problem of the strength of a thin ring loaded by a system of radial and tangential forces. The method suggested for calculating the mechanical stresses and strains originating in the cylindrical shells of a cryogenic turbine generator during sudden short circuiting from the no-load state is illustrated by making a calculation for a 200-kW two-terminal generator. The inner shell is assumed to be made of an aluminum alloy. The shield material is aluminum alloy AMG-6B. Calculation results are presented in tables. The maximum bending stress in the shield during short circuiting equals 219 kg/cm^2 and the maximum torque 54,000 kg·cm, causing tangential stresses of 44 kg/cm^2. The generator discussed has a sufficient strength margin. It is concluded that the calculation method traditionally used for the rotor of a generator of this sort during short circuiting, which takes into account only the effect of the torque, is inadequate for the rotors of cryogenic turbine generators and must be supplemented by the calculation of stresses and strains in shields from the effect of electrodynamic radial and tangential forces. The relative direction of the effect of radial and tangential forces must be taken into account since this determines the most dangerous emergency situation. Figures 4, references 8: 7 Russian, 1 Western.
[198-8831]

UDC 621.311

EXPERIENCE IN USING 800 MW POWER GENERATING UNITS

Kiev ENERGETIKA I ELEKTRIFIKATSIYA in Russian No 2, Apr-Jun 81 pp 8-10

BUGAYOV, A. V. and GORBUNOV, V. D., engineers, Dneproenergo Industrial Power Association

[Abstract] A summary of experience in operating three 800 MW power generating units installed at Zaporozh'ye State Regional Electric Power Plant in 1975-1977. The specific fuel consumption for these three installations averages 321.1 g/kWh, which is 3.9 g/kWh lower than the design rating. Two of the units are operated on a sliding-pressure regime in the steam-water channel of the boiler. Neutral-oxygen water chemistry simplifies servicing, extends the filtering cycles and saves on filter regeneration. Measures of economy have reduced power consumption for internal needs, saving 900 metric tons of ideal fuel per year on each generating unit. The fuel oil is treated with 0.6-0.8 kg of "Polifen" additive per metric ton to reduce problems with cleaning and filtration. Modifications in the boiler system have reduced air infiltration from 230 to 80 kg/hr. Remaining problems that must be dealt with are the low gas-tightness of the boiler, high-temperatre corrosion, low-temperature corrosion, pollutants in flue gases, and a number of operational difficulties with equipment and fittings under starting conditions. These problems are being studied, and some recommendations have already been made on solving them.
[8-6610]

UDC 621.313

IMPROVING RELIABILITY AND ECONOMY OF TURBOMACHINERY IN 300 MW GENERATING UNITS AT PRIDNEPROVSK STATE REGIONAL ELECTRIC POWER PLANT

Kiev ENERGETIKA I ELEKTRIFIKATSIYA in Russian No 2, Apr-Jun 81 pp 13-15

ANDRYUSHIN, V. M. and VAYNSHTEYN, Ya. A., engineers, Pridneprovsk State Regional Electric Power Plant

[Abstract] The authors discuss steps that have been taken to improve reliability and economy of K-300-240 turbines in 300 MW generating units at Pridneprovsk State Regional Electric Power Plant. Modifications have been made in the flow section, the turbine regenerating system and auxiliary equipment. The result has been an improvement in turbine economy by 18-20 kcal/kWh, saving 24,400 metric tons of ideal fuel per year with generation of 8.1 billion kWh. Changes made in starting schedules have cut startup time in half, saving 100 metric tons of ideal fuel per start, which amounts to an average savings of 4200 metric tons per year. Reliability is further improved by a technique of chemical flushing under load. The condensers are kept clean by a rubber-ball system. Figures 2, references 3 Russian.
[8-6610]

INDUSTRIAL TECHNOLOGY

UDC 531.8

ANALYSIS OF MANIPULATOR HAND VIBRATIONS AS SYSTEM WITH DISTRIBUTED PARAMETERS

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian No 6, Jun 81 (manuscript received 19 Nov 79) pp 62-64

VERNIKOV, V. N., candidate of physico-mathematical sciences

[Abstract] The vibrations of a manipulator hand with tong, after impact of the hand against a detent, are analyzed by regarding the hand as a mechanical system with two degrees of freedom rather than only one in the first approximation. At the instant of impact the hand is assumed to have some angular velocity but no strain. In calculations the hand is regarded as a beam with a center of mass, rigidly fixed relative to its axis of rotation and with the masses of the tong and the load both concentrated at its free end. The vibrations of such a mechanical system with distributed parameters are described by the differential equation of transverse vibrations for a beam with the given initial and boundary conditions. Its solution yields the amplitude of vibrations, which is found to be governed by the ratio M/m (M- mass of hand, m- mass of tong and load) only, approaching 0.329 in dimensionless units as M/m → ∞. The results of this analysis indicate that positioning of the manipulator on the basis of approximations such as assuming only one degree of freedom for the hand or a zero mass of tong and load will lead to large errors. Figures 2, references 4 Russian.
[206-2415]

UDC 621-503-4

ABSOLUTE STABILITY OF NONLINEAR CONTROL SYSTEM FOR INDUSTRIAL ROBOT

Moscow MASHINOVEDENIYE in Russian No 4, Jul-Aug 81 (manuscript received 22 Oct 80) pp 16-20

AFONIN, V. L., Moscow

[Abstract] Robots for arc welding are usually controlled with the aid of a digital computer performing the transformation of coordinates between the position tracking optical or other sensors and the servomechanism. Here a simplification of the generally intricate transformation matrix is proposed, namely replacement of this J^{-1}-matrix with the $\Delta \cdot C$ signs matrix (Δ denoting the determinant of the J-matrix

and $C=\Delta I^{-1}$ denoting the transposed matrix of complements to the I-matrix). The gist of this device is that the B-matrix does not contain the denominator by which each element of the transposed matrix of complements must be divided and that, furthermore, not the determinant but only its sign enters into the operation. The servomechanism input and output vectors are related through an equation in which the nonlinear function $K_i\Delta^{-1}$ $\mathrm{sign}\Delta = K_i|\Delta|^{-1}$ appears (K denoting the diagonal matrix of transmission coefficients along each control channel), negative feedback being always ensured with $|\Delta|\neq 0$, and which must be solved for a stability analysis of the control system according to the Sylvester criterion. On this basis, the absolute stability limits of the control system for a "Versatran" robot lifting parts from a conveyor belt, with up to three degrees of freedom and optical sensors, are determined both numerically and graphically. Figures 4, reference 1 Russian.
[208-2415]

UDC 621.01

CERTAIN PROPERTY OF PLANE MULTILINK MANIPULATOR

Moscow MASHINOVEDENIYE in Russian No 4, Jul-Aug 81 (manuscript received 20 Jul 78, after completion 26 Nov 80) pp 10-15

NIKOMAROV, Ya. S., Moscow

[Abstract] An n-link manipulator is defined as a simple kinematic chain consisting of n movable links with a single rigid support at one end. The positions of all links are uniquely determined by the configuration of k independent variables. Here such a manipulator consisting of class-5 rotating pairs is considered, each link assumed to be infinitesimally thin. The unimodality of its distance function, namely the dependence of the radius-vector of the tong on the variables, is demonstrated on the basis of geometric and kinematic relations in a polar coordinate system with the origin at the point of support. The procedure is to first prove it for the case of a single independent variable (2-link manipulator) and then to prove that, if it is true for n-1 variable, it will also be true for n variables. Various practical constraints are considered and singularities are established which comprise the boundary of the service zone, i.e., of the range within reach of the manipulator tong. Figures 2, references 4 Russian.
[208-2415]

UDC 007.52

BASIC SCIENTIFIC-TECHNICAL PROBLEMS IN INDUSTRIAL ROBOTOLOGY

Moscow MASHINOVEDENIYE in Russian No 4, Jul-Aug 81(manuscript received 6 May 80, after completion 14 Oct 80) pp 3-9

YUREVICH, Ye. I., Leningrad

[Abstract] Robotology encompasses the design and manufacture of robots as well as their use for automation of technological processes. Already about 30,000 robots are in operation throughout the world, about 5000 of over 100 different models in the Soviet Union alone. The basic problem areas in the Soviet robot industry are the drive, standardization, application and production. Most robots in the Soviet Union operate with pneumatice drives, hydraulic and electromechanical drives being intensively developed but still remaining inferior to the better foreign ones with respect to speed, precision, size, weight and cost. Standardization should proceed smoothly according to the complex program prepared during the last Five-Year Plan period, with the first two State standards already written. As to the application of robots, the present breakdown is approximately: 35% in forging-press operations, 25% in machining operations, 10% in lifting and transport operations, 8% in casting operations, 8% in painting operations, 6% in galvanic coating operations, 4% in welding operations, 3% in assembly and inspection, 2% in heat treatment. The main tasks facing the Eleventh Five-Year Plan and the remainder of this decade are to continue and extend the production of industrial robots, further improve the control system by introduction of group and adaptive methods with proper utilization of microprocessors and with the aid of large-scale integration, further extending the application of robots to other industries such as coal and ore mining (a typical industry in the consumer goods area, namely the watch-making industry, already uses about 150 minirobots for assembly operations), and to focus standardization on all the component parts of a robot with the necessary documentation. Achievement of these goals will require a great deal of research in the pursuit of novel solutions to design and optimization problems. Figures 4, references 3 Russian.
[208-2415]

UDC 531.8

SIMULATING DYNAMICS OF MANIPULATOR WITH ELASTIC LINKS

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian No 3, May-Jun 81 (manuscript received 30 Apr 80) pp 118-124

AKULENKO, L. D., MIKHAYLOV, S. A. and CHERNOUS'KO, F. L., Moscow

[Abstract] A manipulator is considered which consists of two straight beams linked through an elbow hinge, the first one fastened through a shoulder hinge to a stationary body at the other end and the second one with a wrist hinge at the other end carrying a load. This load is assumed to be a perfectly rigid body with given inertia characteristics and a mass much larger than that of the entire manipulator. Accordingly, the kinetic energy of the manipulator is negligible and the frequencies of its forced elastic vibrations are far below resonance. The angles in the hinges, functions of time, are the kinematic control variables. This manipulator is simulated by an elastic model and by an auxiliary perfectly rigid model with the same hinge angles and beam lengths. Its potential energy is calculated in terms of the translation vector and the rotation vector for each beam, each vector being the sum of one component in the plane of the manipulator and one in a plane perpendicular to it. The difference between the total kinetic energy of the load and the potential energy of the manipulator is the Lagrange function in the Lagrange differential equations of motion which, upon integration, yield the elastic vibrations characterizing the dynamics of the manipulator. Typical results of numerical integration with the aid of a computer are shown where the angles of rotation of the hinges have been assumed to be piecewise-linear functions of time. Figures 5, references 5: 4 Russian, 1 Western.
[215-2415]

TURBINE AND ENGINE DESIGN

UDC 621.431.74-573:621.438

IMPROVING TORSION SHAFT SERVICEABILITY IN GAS TURBINE ENGINE STARTING SYSTEM

Leningrad SUDOSTROYENIYE in Russian No 6, Jun 81 pp 48-51

PODGURENKO, V. S., SHNEYERSON, L. M. and SADYKOV, V. A.

[Abstract] The torsion shafts of the starting systems of gas turbine engines have been observed to fail owing to the repeated shock loading originating when starters are joined up with the engine's rotor via the clutch. The results are given of a study of the influence of certain parameters of the dynamic system and of loading conditions on the serviceability of torsion shafts and of the determination of the optimum technology for treating these shafts. Static torsion tests were made of eight variants of samples subjected to various kinds of heat treatment and differing in the technology used to finish the surface. The samples were made from 40KhN2MA or 40KhNMA steel in keeping with All-Union State Standard 4543-71 and their working section had a diameter of 10 mm and a length of 96 mm. Some samples were nitrided at 510°C to a layer thickness of 0.15 to 0.25 mm to achieve hardness of HV $\geq$ 600, while the remaining were improved by tempering at 560°C, the majority of them prior to machining. Some samples were ball burnished after turning with a 6 mm diameter ball under a strain of 920 N, a feed of 0.07 mm/rev and an r.p.m. of 200. Another group of samples was polished after turning. A special device mounted on the base of a lathe was used for this purpose. Polishing was performed first with a disk made of extruded and vulcanized rubber with an abrasive powder, a foamed plastic disk containing abrasive grit and finally with a felt disk. Samples were polished for 12 to 15 min. Other samples were polished electrochemically employing a sulfuric and phosphoric acid electrolyte at 30 to 35°C with a current density of 0.45 A/cm^2 for 15 min, resulting in the removal of a layer approximately 4 µm thick after 1 min. Other samples were subjected to rough-finish electrochemical polishing with the removal of a layer 0.2 mm thick. Tensile tests were conducted to determine the mechanical properties of the samples, along with torsion tests. The tests demonstrated a substantial dependence of ultimate ductility on the state of the surface, i.e., roughness, the degree of cold work hardening, structure and other factors. Samples which had been polished with the disks in the special unit and then subjected to electrochemical polishing evidenced the highest ductility and those processed by only one of these methods somewhat lower ductility. Tests of samples and torsion shafts, treated by these methods, in engines made it possible to recommend the series production of torsion shafts with a very finely finished surface. These torsion shafts can endure an approximately twofold greater maximum number of starts as compared with shafts improved by heat treatment and an almost 20-fold greater number as compared with nitrided shafts. The reliable performance of these shafts has been proven. Figures 6, references 3 Russian.
[203-8831]

UDC 629.12.03-843.6.001.5:534.013

TORSIONAL VIBRATIONS IN DIESEL ENGINE PLANT WITH LARGE-SCALE SILICONE DAMPER

Leningrad SUDOSTROYENIYE in Russian No 5, May 81 pp 21-23

ALEKSEYEV, V. V. and PAKHOMOV, K. N.

[Abstract] Large-scale silicone dampers were installed on vessels with low-r.p.m diesel engines for the first time in USSR shipbuilding in 1978-79 on six container carriers of the "Sestroretsk" type. These dampers have an outside diameter of 239 cm and a width of 46 cm. The engine-shafting-propeller system of these vessels consists of a two-stroke five-cylinder diesel engine of the 5DKRN62/125 type with power of 4045 kW at 135 r.p.m., the shafting, and a fixed-pitch four-blade screw propeller. Two flywheels are installed on both ends of the engine's crankshaft, but a silicone damper can be installed on the front end of the shaft in place of a flywheel in order to lower the level of torsional vibrations. The results are presented of full-scale tests of the shafting before and after the installation of a silicone damper. The shafting has low compliance because the engine is located in the stern. As a result the resonance is 0.75 times the nominal rotational velocity of the engine. Test results for the shafting are given in the form of the dependence of the peak values of stresses in the intermediate shaft on the rotational velocity. The results of strain measurements performed on the intermediate shaft are presented in a table for the maximum peak values of stresses. Oscillograms are also presented. The data demonstrate that disturbing moments of the engine result in the development of torsional vibrations of the major fifth order of uninodal form. In a system with a damper, as compared with one with a regular flywheel, the maximum peak values of stresses are reduced more than twofold, equaling 32 to 46 MPa with manual control of the engine and 31 to 45 MPa with remote automatic control with a standard deviation of 5.3 and 4.8. In the system discussed the damper is tuned to reduce vibrations of uninodal form and this explains why it lowers the resonance frequency but slightly although its effective moment of inertia is almost twofold greater than that of the flywheel which it replaces. The results are given of a study of the influence of the rate of passing the resonance region on the peak values of torsional vibrations. An analytical dependence is derived which makes it possible to determine the peak value of sustained resonance vibrations from maximum peak values of vibrations and the rate of passing the resonance region obtained from tests. This dependence is recommended for use in analyzing the results of torsiographing engine plants with low-r.p.m. diesel engines. Figures 5, references 4 Russian.
[204-8831]

NAVIGATION AND GUIDANCE SYSTEMS

UDC 521.15:629.195

EFFECT OF GRAVITATIONAL FORCES AND LORENTZ FORCES ON MOTION OF SATELLITE RELATIVE TO ITS CENTER OF MASS

Leningrad VESTNIK LENINGRADSKOGO UNIVERSITETA: MATEMATIKA, MEKHANIKA, ASTRONOMIYA in Russian No 13, Issue 3, Jul 81 (manuscript received 14 Jan 81) pp 85-90

LYAKHOVKA, G. V.

[Abstract] A solid body inside an electrically charged spherical shield is moving as an Earth satellite in the central field of terrestrial gravitation as well as in the geomagnetic field. The center of the shield is displaced from the center of mass of the satellite a certain distance along the principal axis of inertia, the ellipsoid of inertia of the satellite being an ellipsoid of revolution (A= B). The moments of gravitational forces and of Lorentz forces are calculated for this configuration, and the equations of motion in osculating elements are solved for the case of high angular velocity. The results reveal the complex pattern of precession of the vector of angular momentum about the direction normal to the plane of the orbit. They also reveal a stabilizing effect of Lorentz forces acting concurrently with gravitational forces: the trajectories due to the moment of Lorentz forces vanish only when the moment of gravitational forces becomes infinitely larger than the moment of Lorentz forces, but the trajectories due to the moment of gravitational forces vanish even when the latter is smaller than half the moment of Lorentz forces. The author thanks L. I. Kuznetsov for his comments and suggestions. Figures 2, references 4 Russian.
[211-2415]

UDC 531.383

INTEGRATION OF EQUATIONS OF MOTION FOR GYROSCOPE WITH INTERNAL CARDAN SUSPENSION IN SPECIAL CASE

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian No 4, Jul-Aug 81 (manuscript received 24 Mar 80) pp 11-16

SHATALOV, M. Yu., Moscow

[Abstract] A gyro system with an internal Cardan suspension is considered which consists of a shaft inside, a wheel, and a ring outside coupled through respective two mutually perpendicular diametral pairs of torsion springs with negligible damping.

The wheel as well as the shaft and the ring are assumed to be perfectly solid. The torsion springs are assumed to have a finite torsional stiffness and an infinite flexural stiffness. The solution to the exact nonlinear equations of motion is obtained in finite angles for a wheel with equal first and third moment of inertia and with zero torsional stiffness of the pair of springs coupling it to the ring. The corresponding Lagrange function is integrated for asymmetric and symmetric perturbations. The results are applied to a dynamically adjustable gyro and, as the other limiting case, to one which has lost one degree of freedom due to an infinite torsional stiffness of the pair of springs coupling the wheel to the ring. Here the generalized energy integral yields a solution in Jacobi elliptic functions. Figures 2, references 4: 3 Russian, 1 Western.
[4-2415]

UDC 531.01

EFFECT OF GYROSCOPIC FORCES ON STABILITY OF UNIFORM ROTATION OF SOLID BODY AROUND PRINCIPAL AXIS

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian No 4, Jul-Aug 81 pp 1-10

BELIKOV, S. A.

[Abstract] Rotation of an ideal solid around a stationary point in a Newtonian central force field is considered, with the third axis of the stationary system of coordinates passing through the stationary point and the center of the gravitational field. The axes of coordinates on the rotating body coincide with the principal axes of its inertia, its center of mass lying on the first principal axis. The equations of motion with the Hamilton function in Euler angles, for the case of gyroscopic forces acting on the body which are linear with respect to the generalized velocities, are reduced to canonical form with two degrees of freedom and corresponding two angular velocities. The stability of the body motion under these conditions is analyzed in terms of permissible values of the problem parameters, two special cases being one where both angular velocities are equal and one where one of them is zero. A theorem is derived for the regions on a hypersurface within which such gyroscopic forces respectively do and do not stabilize the uniform rotation of a body. The results are applicable to an Earth satellite. Figure 1; references 12 Russian.
[4-2415]

UDC 531.55:521.1

MAGNETIC SUSPENSION SYSTEMS IN SERVO COMPONENTS CONTROLLING SPACECRAFT ORIENTATION

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian No 3, May-Jun 81 (manuscript received 3 Sep 79) pp 152-157

VEYNBERG, D. M., VERESHCHAGIN, V. P., DANILOV-NITUSOV, N. N. and SHEREMET'YEVSKIY, N. N.

[Abstract] Several types of magnetic suspension are described and comparatively evaluated for use as bearings in flywheel and gyro mechanisms controlling the orientation of spacecraft. Passive magnetic bearings have an intrinsic stability, they utilize the force of repulsion between like poles of permanent magnets as in a radial bearing or the centering force between teeth on two ferromagnetic structures as in an induction motor. While permanent magnets made of modern samarium-cobalt alloys produce a force density as high as 10^5 N/m^2, the main problems with the use of such bearings are damping radial vibrations and ensuring axial stability of the wheel. Since it is not possible to construct a stable bearing with permanent magnets alone, a passive suspension is always combined with an active one. Stability of active suspensions is attained by regulation of the current. Active magnetic bearings utilize the force of attraction between a ferromagnetic rotor and the field of a stationary electromagnet or the force of interaction between the current in the stator winding and the field of permanent magnets in the rotor. The external force controlling the force of attraction or interaction is regulated by regulation of the current through a feedback system. While high force densities can be produced here, up to $6 \cdot 10^5$ N/m^2 with plain electrical-grade steels and up to $15 \cdot 10^5$ N/m^2 with magnetically soft precision alloys, the main problems are design of a bearing with economic use of materials and design of a reliable high-speed electronic control circuit. Figures 9; references 9: 5 Russian, 4 Western.
[215-2415]

UDC 531.383

GYRO-HORIZON COMPASS STABILITY IN NEWTONIAN GRAVITATIONAL FORCE FIELD

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian No 3, May-Jun 81 (manuscript received 26 Nov 79) pp 114-117

ZAVOZIN, Zh. G., Komsomol'sk na Amure

[Abstract] The stability conditions for a gyro-horizon compass moving in a newtonian central gravitational force field are established on the basis of the motion equation for a gyro implied by the angular momentum theorem, and with the orientations of the gyro axes defined through three Euler-Krylov angles. These conditions are found to be applicable to a gyro-horizon compass mounted on a satellite moving along a circular orbit in this field. The author thanks G. D. Blyumin for interest and valuable suggestions. References 10: 9 Russian, 1 Western.
[215-2415]

UDC 531.36

PERMANENT ROTATION OF GYROSTAT WITH SELF-EXCITATION

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian No 3, May-Jun 81 (manuscript received 3 May 79) pp 107-113

SMOL'NIKOV, B. A. and STEPANOVA, M. V., Leningrad

[Abstract] A free gyrostat is considered with a constant angular momentum and a constant Grammel self-excitation torque, the former produced by a wheel arbitrarily oriented inside the housing or by a set of wheels with axes of rotation fixed relative to the three principal central axes of inertia of the gyrostat, and the latter produced by a set of jet engines mounted on the housing. The stability of gyrostat rotation about any of all possible permanent axes and the orientations of these axes relative to the principal axes of the gyrostat are determined from the equation of forced motion and the solution to the latter for the projections of the constant angular velocity on these three principal axes. The stability of rotation is found to be determined not only by the parameters of motion but also by the behavior of the forcing torque during small excursions of the vector of angular velocity from its nominal direction. The axes of permanent rotation are found to be discrete or to form continuous surfaces, depending on the initial conditions. Figures 4, references 3: 1 Russian, 2 Western.
[215-2415]

UDC 531.55:521.1

STABLE MOTION OF AIRCRAFT WITH SINGLE-CHANNEL STABILIZER RELATIVE TO ITS CENTER OF MASS

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian No 3, May-Jun 81 (manuscript received 15 May 79) pp 102-106

KUKHTEVICH, S. Ye., Moscow

[Abstract] An axisymmetric aircraft is considered which together with its center of mass moves forward in a horizontal direction at a constant velocity. It is subject to aerodynamic torques tending to veer it from its course and proportional to the sines of the respective angles of rotation about its transverse axes of inertia, also to a constant torque in the direction of its longitudinal axis of inertia and a damping torque in the same direction but proportional to the instantaneous angular velocity about this axis. The aircraft stabilizer consists of a single 2-stage gyro with a constant angular momentum in the direction of forward motion and a servomechanism which generates a restoring torque in the direction of the horizontal transverse axis of inertia and proportional to the sine of the angle between this axis and the projection of the forward velocity on the transverse plane. The stability of the aircraft motion relative to its center of mass is analyzed on the basis of two equations describing this motion. These equations with periodic coefficients

are reduced by a Lyapunov method to equations with constant coefficients. The imaginary part of the complex characteristic equation has three roots, which determine the region of simple stability. When the aerodynamic torques are sufficiently small, this region becomes one of asymptotic stability or one of exponential instability, depending on whether the term under the square root sign is positive or negative. Figures 4, references 4 Russian.
[215-2415]

UDC 531.38

STABILIZING ROTATION OF SOLID BODY BY MOVABLE MASSES

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian No 3, May-Jun 81 (manuscript received 3 Jan 80) pp 96-101

KACHURINA, N. M. and KREMENTULO, V. V., Moscow

[Abstract] A mechanical system free of external forces is considered consisting of a solid body with a stationary point where three axes of inertia intersect and two masses free to move along straight grooves in this body parallel to the principal axis. The problem of optimally stabilizing the rotation of this body about the principal axis by means of internal forces in the system is analyzed according to the theory of control. The theorem pertaining to change of angular momentum relative to the three axes of inertia yields for this mechanical system three equations, to which nine Poisson equations of kinematics and two equations of relative motion for the material points representing the two masses are added. This closed system of fourteen equations in phase coordinates is transformed to one in Cauchy variables and then solved for the two control moments associated with the two masses, which will ensure asymptotic stability of permanent rotation about the principal axis of inertia. The optimization problem involves minimization of a functional which is the time integral from zero to infinity of a positive-definite function of the stabilizable variables and the stabilizing moments. Figure 1; references 6: 4 Russian, 2 Western.
[215-2415]

HIGH-ENERGY DEVICES, OPTICS AND PHOTOGRAPHY

UDC 536.3

INVESTIGATION OF POWER DISTRIBUTION OF INTERNAL HEAT SOURCES IN ILLUMINATOR ELEMENTS

Leningrad IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: PRIBOROSTROYENIYE in Russian Vol 24, No 8, Aug 81 (manuscript received 10 Jun 80) pp 92-96

[Article by L. A. Savintseva, A. V. Sharkov, V. G. Parfenov and V. A. Gur'yanov, Leningrad Institute of Precision Optics and Mechanics]

[Text] The most significant factors that determine the power distribution of an internal heat source in an active element are explained in accordance with data of analysis of calculations done by a program based on a Monte Carlo method.

In designing illuminators, it is important to analyze the temperature conditions of their operation based on calculations. One of the major stages of the calculation is determination of the distributions of volumetric heat sources that arise in illuminator components as pumping radiation is absorbed. An approximate method was proposed in Ref. 1 for calculating integral powers of internal heat sources in individual elements. It was assumed that the radiation is isotropically incident on the surface, and that energy is uniformly distributed within these elements. However, such assumptions are rather rough for detailed investigation of the temperature fields of individual illuminator components since energy is distributed nonuniformly within the active element even when radiation is isotropically incident on its surface because of attenuation in the medium and refraction on the lateral cylindrical surface [Ref. 2].

This article gives the results of calculation of the distribution of surface flux density incident on an active element, and also the distribution of power of volumetric heat sources in the active element in accordance with a program based on a Monte Carlo method, revealing the most significant factors that determine the nature of these distributions. The Monte Carlo method was also used in calculating pumping systems in Ref. 3, 4.

The algorithm and program of calculation on a digital computer have been developed for a class of illuminators that are now in wide use, in which the pumping lamp 2 is placed parallel to the axis of active element 1 (Fig. 1). Various modifications of such a design are possible. Channels 3, 4 that carry coolant or liquid filters can be placed around the active element and pumping lamps. Illuminators 5 may be of monoblock design with specular or diffuse reflective coating. The surface of the active element may be polished or dull. One or more pumping lamps may be placed around the active element.

It was assumed in the calculation that the plasma of the pumping lamp is transparent to self-radiation, and that emission of the lamp is incident on the active element in the direction perpendicular to its axis (i. e. the planar problem was considered).

The process of radiation modeling begins with the surface of the lamp envelope. It is assumed that this envelope radiates in accordance with Lambert law. Energy radiated by the lamp in wave band d_λ can be determined from the spectral curve of radiation of the lamp [Ref. 5].

The given spectral energy is transported by N beams of energy. In the process of tracing these beams, consideration is taken of laws of refraction, reflection and absorption. Beam travel is traced up to the point where the beam of energy is absorbed in the given system.

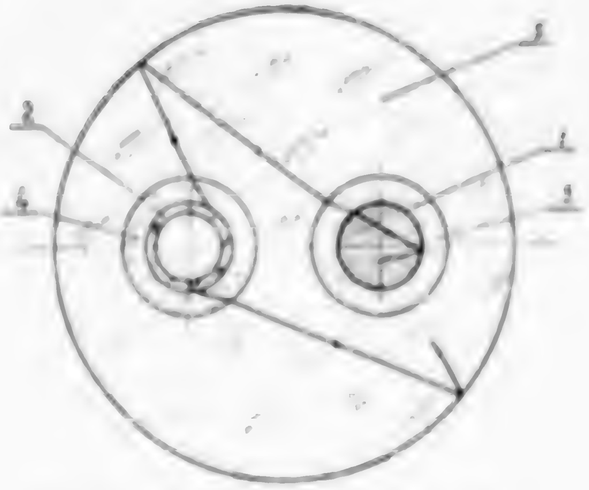

Fig. 1. Schematic diagram of illuminator design

Thus, the initial data for the calculation are: the structure and geometry of the illuminator, the indices of refraction of the media under consideration, and the spectral distribution of lamp radiation energy. The calculations were done for the system shown in Fig. 1. The reflector of the illuminator is a cylindrical quartz monoblock of diameter d_0 with specular or diffuse reflective coating and spectral reflectivity R, index of refraction n_0 and spectral coefficient of absorption of the monoblock K_0. The pumping lamp is a cylinder of diameter $d_б$, and the external surface of the lamp is cooled by a heat-transfer agent with index of refraction $n_{жб}$ and spectral coefficient of absorption $K_{жб}$. The active element is a cylinder with diameter d_a, index of refraction n_a and spectral coefficient of absorption K_a. The outer surface of the active element is polished and cooled by a fluid with index of refraction $n_{жа}$ and spectral coefficient of absorption $K_{жа}$. The distance between the centers of active element and pumping lamp is l. The Table summarizes the numerical values of the parameters used in the calculations.

TABLE

Illuminator №	d_0, мм	d_a, мм	$d_б$, мм	$d_{жа}$, мм	$d_{жб}$, мм	l, мм	R	$K_ж$, 1/мм
1	[illegible]	6 8	8	12	12	14	0.6–0.95	0
2	28	7	8	6	12	12	0.6–0.9	0
3	25	[illegible]	[illegible]	6	12	12	0.7	0.01

[table continued on following page]

[continuation of table from preceding page]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Coating
0,1	[illegible]	[illegible]	1,15	1,55	1,32	1,33	Specular
0,07	"	"	1,5	1,55	1,31	1,31	Specular and diffuse
0,02	"	[illegible]	1,5	[illegible]	1,6	1,33	Specular

Based on the results, an examination is made of the influence of different factors on the transfer coefficient of the illuminator (the ratio of the energy that reaches the active element as a result of multiple reflections from the surface of the reflector, to the energy radiated by the lamp), on the degree of nonuniformity of the distribution of surface flux density on the active element, and on the nature of distribution of power of an internal heat source of the active element.

Analysis of the results showed that the most significant factors influencing the transfer coefficient are: reflectivity and type of reflective coating, relative placement and dimensions of lamp and active element.

Fig. 2 shows the dependence of the transfer coefficient of the illuminator monoblock on reflectivity of the specular coating of the reflector, and also on the ratio of diameters of active element and pumping lamp. The calculation used data given for illuminator 1 in the Table. The spacing between centers of the active element and pumping lamp has a considerable effect on the transfer coefficient. As their axes approach and the intercenter spacing changes (see data for illuminators 1 and 2 in the Table), the transfer coefficient increases by 16%.

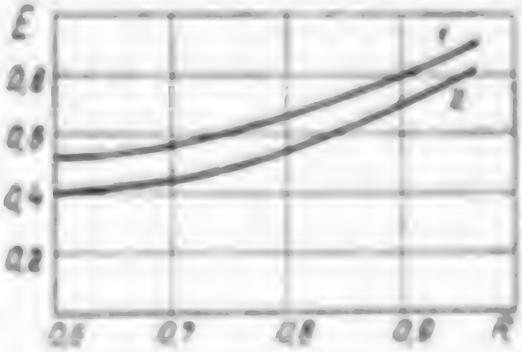

Fig. 2. Transfer coefficient of illuminator as a function of reflectivity of specular reflector coating

[illegible]

Studies have shown that use of a diffuse reflective coating reduces the transfer coefficient. For example, when the specular reflective coating is replaced by a diffuse coating (see illuminator 2 in the Table), the transfer coefficient decreases by 15%. The relative error of calculation of the transfer coefficient in the assumed thermal and mathematical model did not exceed 5% at a confidence coefficient of 99.9% [Ref. 6, 7].

Investigation of the nature of distribution of the surface density of the flux incident on the active element showed that this distribution depends strongly on the geometry of the elements of the system, on the reflectivity of the reflector, and on the type of reflecting surface (specular or diffuse).

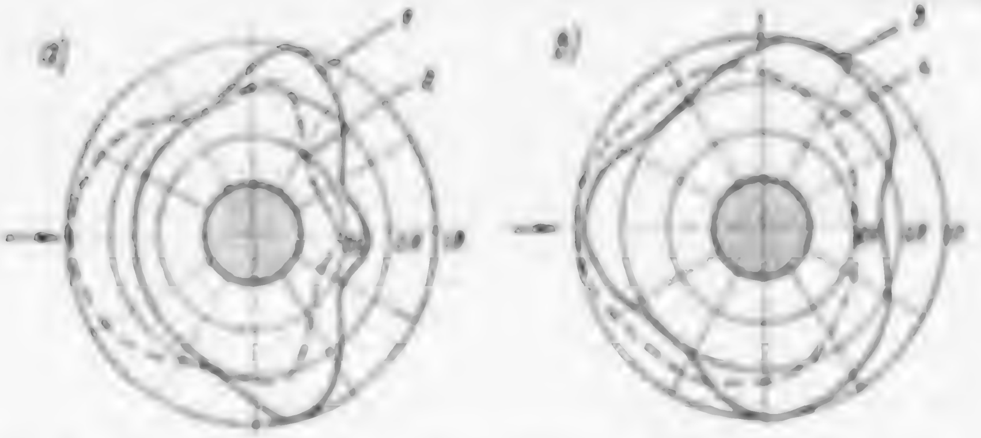

Fig. 3. Distribution of surface density of flux incident on the active element as a function of reflectivity (a) and type of reflective coating (b):
(← indicates the direction of lamp radiation)
1--R = 0.9; 2--R = 0.6; 3--specular reflective coating;
4--diffuse reflective clating

Fig. 3a shows the angular dependence of the distribution of surface density of the flux incident on the active element as a function of the reflectivity of the reflector. For purposes of clarity, the diagram shows the ratio of the instantaneous value of the density to the maximum value on the surface of the active element. As we can see from Fig. 3a, the incident flux density depends rather strongly on the angular coordinate.

The influence of lamp radiation shows up most strongly at lower reflectivities. Displacement of the maximum of surface density of the incident flux in the direction of the pumping lamp is also observed as the distance between the axes of the active element and lamp decreases. Diffuse reflective coatings give somewhat more uniform distribution (Fig. 3b). At the same time, this type of coating reduces the surface density of the incident flux on the shaded part of the active element.

Let us consider the distribution of power of an internal heat source in the active element. Fig. 4a (see Table, illuminator 3) shows the distribution of surface density of the incident flux, and Fig. 4b shows the distribution of power of internal heat sources in the active element. The contour lines map equal volumetric energy density in the active element. Here we can see a trend toward displacement of the maximum power of an internal heat source toward the pumping lamp.

The program running time is appreciably dependent on the efficiency of the system, on the coefficient of absorption of the media considered, etc. For the investigated illuminators, the running time for one spectral interval ranged from 10 to 30 min (the value of N reached 1600).

Experimental verification of nonuniformity of the distribution of surface density of the flux incident on the active element showed satisfactory agreement with calculations. The results given in this paper demonstrate that the distribution of

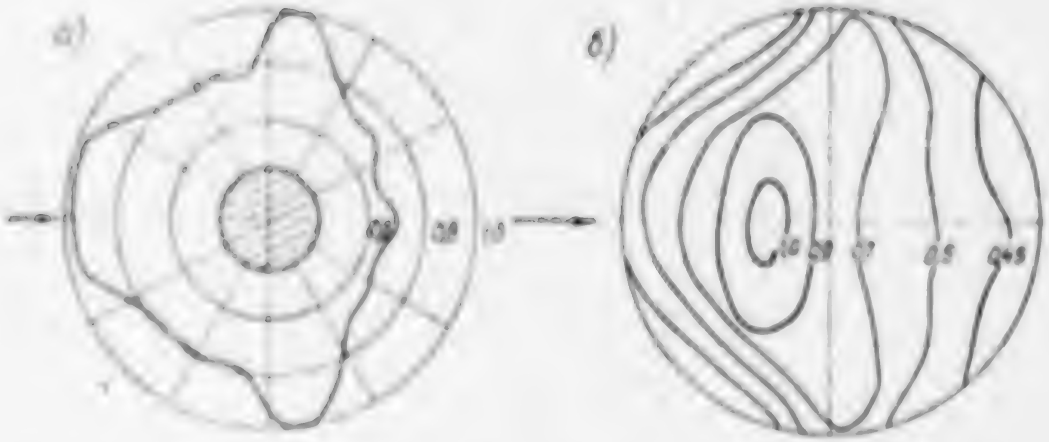

Fig. 4. Distribution of surface density of incident flux (a) and power of internal heat sources (b) in active element (→ indicates direction of lamp radiation)

REFERENCES

1. Savintseva, L. A., Sharkov, A. V., Chastyy, V. L., "Calculating Power of Internal Heat Sources in Systems That Contain a High-Intensity Radiation Source", IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: PRIBOROSTROYENIYE, Vol 21, No 3, 1978, p 102.

2. Stepanov, B. I., ed., "Metody rascheta opticheskikh kvantovykh generatorov" [Laser Design Techniques], Vol 2, Minsk, Nauka i tekhnika, 1968.

3. Skinner, D., Tregellas-Williams, J., "Total Energy and Energy Distribution in a Laser Crystal due to Optical Pumping as Calculated by the Monte-Carlo Method", AUSTRAL. J. PHYS., Vol 19, 1966, p 1.

4. Dorugov, V. G., Shcherbakov, A. A., Yakovlev, A. V., "Using the Monte-Carlo Method to Calculate Laser Pumping Systems", ZHURNAL PRIKLADNOY SPEKTROSKOPII, Vol 30, No 2, 1979, p 246.

5. Doynikov, A. S., "Obzory po elektronnoy tekhnike, seriya Elektrovakuumnyye i gazorazryadnyye pribory" [Surveys on Electronic Engineering, Series on Vacuum Tubes and Gas-Discharge Devices], Central Scientific Research Institute of Electronics, No 11(136), Moscow, 1973.

6. Shreyder, Yu. A., ed., "Metod staticheskikh ispytaniy (metod Monte-Karlo)" [The Method of Statistical Tests (Monte-Carlo Method)], Moscow Fizmatgiz, 1962.

7. Zigel', R., Khauell, Dzh., "Teploobmen izlucheniyem" [Heat Transfer by Radiation], Moscow, Mir, 1975.

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CSO: 8144/1136

UDC 551.521.3:621.375.826

TEMPERATURE VARIATION IN AMBIENT MEDIUM OF AQUEOUS AEROSOL VAPORIZED BY CO_2-LASER BEAM

Minsk INZHENERNO-FIZICHESKIY ZHURNAL in Russian Vol 41, No 2, Aug 81
(manuscript received 8 Dec 80) pp 341-342

DIDENKO, N. K. and PINCHUK, S. D.

[Abstract] An experimental study was made concerning the vaporization of a polydisperse aqueous aerosol by the beam from a CW CO_2-laser beam and the attendant local heating of the ambient medium through heat transfer from hot evaporating droplets under conditions of forced convection. The condition $r_0 N^{2/3} \chi/v > 1$ (r_0- radius of the laser beam, N- concentration of droplets, χ- thermal diffusivity, v- velocity of the stream), ensuring quasi-continuous heat generation along the path of the laser beam, was maintained throughout the experiment in a $3.2 \cdot 10^3$ m^3 fog chamber with up to 700 W radiation source. The results of measurements agree satisfactorily with calculations of the temperature field on the basis of an approximate analytical solution to the two-dimensional problem of heat conduction, in the plane containing the direction of radiation propagation (x-axis) and the direction of stream velocity (y-axis), with nonlinear distortion of the laser beam taken into account. Manuscript of the full article with 21 bibl. references deposited at the All-Union Institute of Scientific and Technical Information, received here 23 Apr 80.
[213-2415]

UDC 536.621.373

THERMAL CONDITIONS OF THE LIGHT GENERATING SYSTEM OPTICAL ELEMENTS IN SOLID-STATE LASER WITH NATURAL COOLING

Minsk INZHENERNO-FIZICHESKIY ZHURNAL in Russian Vol 41, No 2, Aug 81
(manuscript received 13 May 80) pp 295-301

DUL'NEV, G. N. and KHANKOV, S. I., Leningrad Institute of Precision Mechanics and Optics

[Abstract] The temperature distribution in the active cell is the most important factor affecting the design and the performance of a solid-state laser. Here a practical approximate analytical solution to the problem of determining it is shown, an exact solution being quite cumbersome and requiring the aid of a computer. The light generating optical system of a solid-state laser consists essentially of three elements: two parallel cylinders with heat sources (lamp and active cell) inside a heat emanating cylindrical shell (luminaire). Calculation of their temperatures reduces to integration of a system of three first-order linear ordinary differential equations, if the cylinders are assumed to have a large length-to-diameter ratio, that heat emanation occurs at their lateral surface only and quasi-continuously under conditions of natural cooling while the laser operates in the periodic-pulse mode, and that the heat transfer coefficients as well as the thermophysical

properties of the materials do not depend on the temperature. This system of equations is solved under two additional assumptions, namely that the luminaire heats up much slower than the lamp and the active cell, and that the thermal flux from the lamp to the active cell is much smaller than that from the lamp to the luminaire. On this basis, for typical length-to-diameter ratios $L/D \geq 10$, the excess temperatures of the three elements are calculated as functions of the average pumping power up to 1000 W in the steady-state mode and as functions of the laser operating time at an average pumping power of 25 W during the transient period, for a YAG:Nd^{3+} laser and an ISP 600 flash lamp. Also calculated are the thermal conductances (W/K) between the three elements and from the luminaire to the ambient medium, as functions of the average pumping power in the steady-state mode. The results are compared with experimental data. Figures 3; references 11 Russian.
[213-2415]

UDC 621.375.826

CHARACTERISTICS OF CARBON MONOXIDE GAS-DISCHARGE OVERTONE-LASER: I. STEADY STATE

Minsk INZHENERNO-FIZICHESKIY ZHURNAL in Russian Vol 41, No 2, Aug 81
(manuscript received 10 Jun 80) pp 289-294

KONEV, Yu. B., KOCHETOV, I. V., KURNOSOV, A. K., PEVGOV, V. G. and DEM'YANOV, A. V., Institute of High Temperatures, USSR Academy of Sciences, Moscow

[Abstract] CO overtone-lasers with high efficiency in the near infrared range of the spectrum are used for various processes in the chemical industry such as separation of isotopes. An earlier study of the populations of vibrational states has indicated the feasibility of a partial inversion at $J - 1, v \rightarrow J, v - k$ transitions not only when $k=1$ but also when $k \geq 2$, with the theoretical gain on the first overtone exceeding $0.1\ m^{-1}$ under experimental conditions. In this study a numerical solution of the system of kinetic equations for the populations of levels, including the Boltzmann equation, yields the distribution of CO molecules over vibrational levels and the spectrum of emission on vibrational-rotational transitions. The first overtone is of practical interest, the beginning of its spectrum shifting from v= 12-14 level at a low temperature (80 K) to v= 20-22 levels at higher temperatures (140-180 K) and its peak shifting correspondingly to v= 24-26 levels. The spectrum of the first overtone is also rather wide, owing to the proximity to the threshold, its long-wave edge corresponding to v= 30-32 levels at all these temperatures. The efficiency of emission has been calculated as a function of the temperature and, at the higher temperatures, as a function of the pumping power. The problem of selective emission is also considered, the efficiency depending on the vibrational transition for the first overtone at which a given line of the spectrum corresponding to the maximum gain with respect to the rotational quantum number is extracted. An efficiency of 28% seems to be attainable at $W= 1\ W/cm^3$ and $T= 150$ K with $G= 5.10^{-4}\ cm^{-1}$ when $n_{CO}= 1.8 \cdot 10^{17}\ cm^{-3}$ and $n_{He}= 1.8 \cdot 10^{18}\ cm^{-3}$. Figures 4, references 8 Russian.
[213-2415]

UDC 621.373.826.038.824

DYE LASER OPERATING IN PULSE REPETITION MODE WITH OPTICAL PUMPING

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul-Aug 81
(manuscript received 22 Feb 80) p 265

GUKETLEV, Yu. Kh., ZHIL'TSOV, V. I., KONSTANTINOV, B. A., NIKIFOROV, V. G. and SOPIN, A. I.

[Abstract] A dye-laser set is described which consists of an illuminator, a control and power supply module, an autonomous dye pumping system and an autonomous water pumping system. Stadard dye solutions are excited from an INP2-5/75A xenon lamp with an initial xenon pressure of 50 torr, this lamp being ignited by discharge of a 0.22 μF capacitor from a voltage of 14 kV. The resonator cavity is formed by plane dielectric mirrors with characteristics optimally matching the given dye. Wavelength tuning, over the 450-700 nm range, is effected by rotation of a Fabry-Perot interferometer in the set through the appropriate angle. The laser generates pulses of duration not exceeding 1 μs (at the 0.5 level) with a 0.7 nm wide spectral line and an average power up to 0.25 W, depending on the dye. The set operates from a 220 V - 50 Hz line, drawing 1.5 kW. It weighs 150 kg. Figure 1.
[1-2415]

UDC 536.581.3

ANNIHILATION CHAMBER FOR MEASUREMENT OF ANGULAR CORRELATION BETWEEN TWO GAMMA-RADIATION PHOTONS AT TEMPERATURES FROM -195 TO +800°C

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul-Aug 81
(manuscript received 18 Feb 80) pp 37-38

AREF'YEV, K. P., VOROB'YEV, S. A. and TSOY, A. A., Scientific Research Institute of Nuclear Physics, Tomsk Polytechnic Institute

[Abstract] A positron annihilation chamber for research in solid-state physics has been built where the angular correlation of annihilation radiation can be recorded at temperatures from -195 to +800°C. The rate of count of binary coincidences is measured as a function of the angle of scatter of annihilation photons. Operation at high temperatures is made possible by special cooling of the Na^{22} positron source. Intermediate temperatures from -195 to +25°C can, moreover, be maintained by means of a dropping device. Fast heating of the specimen to a given test temperature and its subsequent cooling are controlled by switching the electric heater and regulating the supply of liquid nitrogen. The experimentally established 31 mm distance from the Na^{22} source to the target specimen ensures maximum utilization of the positron beam and elimination of the background noise of random coincidences. Figure 1, references 3: 1 Russian, 2 Western.
[1-2415]

UDC 539.107.6

SYSTEM FOR TRACING BREMSSTRAHLUNG PHOTONS WITH SUPPRESSION OF MUON BACKGROUND NOISE

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul-Aug 81
(manuscript received 7 Jul 80) pp 39-41

ALEKSANDROV, Yu. A., BARANOV, S. S., BELOUSOV, A. S., BUDANOV, N. P., VAZDIK, Ya. A., GOVORKOV, B. B., KIM, V. V., KOZLOV, V. A., KREYSKOP, L. M., MAISHEYEV, V. A., MALINOVSKIY, Ye. I., PAVLOVSKAYA, V. V., SERGIYENKO, V. I., SOLOV'YEV, Yu. V., TAMM, Ye. I., FROLOV, A. M. and KHABLO, V. A., Institute of Physics, USSR Academy of Sciences, Moscow

[Abstract] A system for tracing monochromatic bremsstrahlung photons with suppression of muon background noise was used in an experiment pertaining to photomeson production with 15-30 GeV gamma-quanta in the Serpukhov proton accelerator. This system included a 31±1 GeV/c pulsing electron beam with three scintillation counters, a magneto-optical channel, a lead (Pb) radiator, a tracing magnet with eight anticoincidence counters, nine scintillation counters followed by nine Cerenkov total-absorption spectrometers with hexahedral lead-glass radiators, a lead (Pb) absorber of the residual electron beam, a scintillation counter in the anticoincidence mode in the path of the beam, a helium duct for reducing the absorption of gamma-bremsquanta along their path to the target, another Cerenkov spectrometer with a KRS single-crystal radiator, two anticoincidence counters for supression of electrodynamic processes of photon and electron pair generation which would disturb the electron-photon correlation, and two hodoscopes for initial tuning of the electron beam. The use of Cerenkov spectrometers with properly set threshold levels for the triggering signal improved the efficiency of the tracing systen to 98.5%, as compared with 85% efficiency of a conventional tracing system, and also its resolving power. Figures 2, references 6: 5 Russian, 1 Western.
[1-2415]

UDC 539.1.074.8

GASEOUS OPTICAL NEUTRON DETECTOR

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul-Aug 81
(manuscript received 11 Mar 80) pp 51-56

DMITRIYEV, A. B., IL'YASHENKO, V. S., MIS'KEVICH, A. I., SALAMAKHA, B. S. and SARYLOV, V. N.

[Abstract] An experimental prototype of a gaseous optical neutron detector was built and subsequently tested in use with the IRT-2000 reactor at the Moscow Institute of Engineering Physics. The device includes a 580 mm long tubular probe made of Kh18N9T steel (12 mm diameter, 0.75 mm wall thickness), coated with a 2.1 mg/cm^2 amorphous layer of boron+ 93% B^{10} isotope as an emitter of charged particles, capped at one end, and connected at the other end to a 7900 mm long tubular light conductor consisting of two segments made of Kh18N9T steel (12 mm diameter, 0.5 mm wall

thickness). This light conductor is evacuated of air and filled with a gas mixture at the other end. The measuring equipment behind it includes a preamplifier and a photoreceiver (FEU-79 photomultiplier), an amplifier, a discriminator-intensimeter, a high-voltage power supply and a recording instrument on a 25 m long cord. The detector was used in the vertical channel of the 2500 kW reactor, with exposure to gamma-radiation and thermal neutrons. It was tested for linearity (within 5% over the $4\cdot10^7$-$1\cdot10^{10}$ neutrons/cm$^2\cdot$s range), sensitivity (10^6 neutrons/cm$^2\cdot$s and $4.6\cdot10^{-5}$ pulse/neutron$\cdot$cm^{-2}) and stability (within ±3.5% for 420 h with a total accumulation of $1.5\cdot10^{16}$ neutrons/cm^2). The detector was found to be somewhat selective with respect to the gas composition but not very sensitive to the gas pressure. Its temperature sensitivity could not be measured directly, but indirect data indicate a total output signal in the 585.2-724.5 nm band of wavelengths only 5.5% smaller at 250°C and only 16% smaller at 350°C than at 80°C. Insertion of a narrowband light filter before the photoreceiver and recording of a signal at individual wavelengths should further improve the temperature stability of the photoreceiver and thus of the entire detector. The authors thank V. P. Kazakova, Ye. I. Cherkasov, V. V. Fedulov for the assistance in constructing the detector, and the staff of the Moscow Institute of Engineering Physics for the assistance in testing it. Figures 2, tables 2, references 11: 9 Russian, 2 Western.
[1-2415]

UDC 621.387.3

GAS-DISCHARGE ELECTRON GUN WITH BEAM EXTRACTION INTO MEDIUM-PRESSURE GAS

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul-Aug 81
(manuscript received 21 Jan 80) pp 169-171

GITT, V. D., NOSKOV, D. A., ORLIKOV, L. N., RYL'TSEV, P. I., TIKHOMIROV, S. I. and CHIKIN, Ye. V., Tomsk Institute of Automatic Control Systems and Electronics

[Abstract] A gas-discharge single-beam electron gun with a gas-dynamic window has been built for an accelerating voltage of 60 kV. The discharge system consists of a cold aluminum cathode and a 3-disk segmental copper anode with axial holes. The electron beam is focused by a magnetic lens. The window is formed by two copper cups screwed into water-cooled copper disks. The glow-discharge ignition pressure and thus the operating pressure range corresponding to the 0-20 mA discharge current range depends on the gas: 1.1 Pa and 5.2-32 kPa with CO_2, 1.3 Pa and 16-64 kPa with N_2, 8.6 Pa and up to 100 kPa with He. The maximum permissible current density in a wide electron beam is not limited by the capability of the window and can reach tens of mA/cm^2. Figures 3; references 10: 6 Russian, 4 Western.
[1-2415]

UDC 621.375.8

MAGNETO-OPTICAL POLARIZATION MODULATOR FOR PULSED LASER RADIATION

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul-Aug 81
(manuscript received 28 Dec 79) pp 191-192

ZHILENIS, A. A. and KRAUYALIS, R. Yu., Institute of Physics, LiSSR Academy of Sciences, Vilnius

[Abstract] A polarization modulator for pulsed laser radiation is described which utilizes the Faraday effect. It includes an ironless solenoid with 120 turns of wire in three layers on a Textolite core 160 mm long and 25 mm in diameter, producing a sufficiently high magnetic field intensity in the active element, and a glass rod 120 mm long and 20 mm in diameter. The solenoid is energized with current pulses of 1.3 ms duration and 3 kA maximum amplitude from an LC-type pulse generator which includes eight 200 μF -- 1000 V capacitors and a T2-320 pnpn-type switch. This generator is triggered by 5-7 V/10-15 μs pulses from a control circuit. The modulator rod rotates the angle of linear polarization of 1 ns - 1 μs pulses of 1.06 μm (with a repetition rate up to 1 Hz) through angles ranging from -180 to +180°. Reflection is avoided by clearing the end faces of the rod for the 1.06 μm wavelength. Figure 1, references 3: 2 Russian, 1 Western.
[1-2415]

UDC 621.373.018.756:621.373.029.67

MODE-LOCKED LASER PULSE SELECTOR

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul-Aug 81
(manuscript received 14 Feb 80) pp 192-194

BAKINOVSKIY, K. N., BARANOV, G. N., SHAVEL', N. N. and SHARONOV, G. V., Scientific Research Institute of Physical Application Problems, Belorussian State University, Minsk

[Abstract] A simple method of extracavity pulse selection has been devised for an Ar^+-laser with active mode locking. The main feature of the pulse selector is a high-voltage amplifier-limiter with gate control which receives the reference signal coming from a frequency divider through a frequency selector and a pulse shaper. The length of the pulse train at the input to this amplifier-limiter can be regulated discretely by varying the number of diodes in the delay circuit of the pulse shaper, the duration of a pulse being approximately 24 ns with the switch open and approximately 16 ns with the switch closed. The amplifier-limiter converts a 40 V pulse to a 1500 V pulse of 8 ns duration and sends the latter to the electron-optical modulator of laser pulses. While switching elements and avalanche devices in conventional pulse selectors limit the pulse repetition rate at the modulator output to 10 kHz only, the new device raises this limit to 100 kHz. Experiments with a 125 MHz pulse laser and a continuous-wave laser have established the feasibility of obtaining a transmission window narrower than 16 ns with a pulse repetition rate up to 100 kHz. Figures 3, references 5: 2 Russian, 3 Western.
[1-2415]

UDC 621.317.382/384:621.375.826

WIDEBAND DIGITAL INTEGRATED-CIRCUIT WATTMETER FOR LASER RADIATION

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul-Aug 81
(manuscript received 25 Apr 80) pp 197-199

KIRILLOV, A. I., KISHKO, V. I. and MORSKOV, V. F.

[Abstract] A wattmeter for measuring the radiation power of an He-Ne laser (λ= 0.63 μm) has been built with three sensitivity levels: 0.1 V/μW in the 10^{-8}-10^{-4} W range, 0.01 V/μW in the 10^{-4}-10^{-3} W range, 0.001 V/μW in the 10^{-3}-10^{-2} W range. It operates with autocompensation of the source (photodiode) current and subsequent analog conversion of the voltage proportional to the radiation power to frequency (1-10^4 Hz). The integrated-circuit (K544UD1A) operational amplifier with a 470 kilohm feedback resistor has a gain of 5.10^4, the load resistance being only 40 ohms. The frequency at the output of this analog voltage-to-frequency converter, which includes two more operational-amplifier (K153UD1A) stages, is read with an integrated-circuit (K155) frequency meter as the reciprocal of the period measured with counters. The frequency meter includes a range selector $f_0/10^n$ (n= 0-3) with a frequency divider, which widens the dynamic range of the instrument without additional counter stages and a code comparator. The wattmeter is linear within 0.02% and its temperature stability is within 6% over the -10 to +40°C range. The discretization error is within 2%, the calibration error is within 3%. Figures 2, references 8 Russian.
[1-2415]

UDC 621.383.98

WIDEBAND PHOTOELECTRON RECEIVER

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul-Aug 81
(manuscript received 3 Mar 80) pp 199-202

AGISHEV, R. R., IL'IN, G. I. and PIKULEV, A. N., Kazan' Aviation Institute imeni A. N. Tupolev

[Abstract] A universal wideband photoreceiver has been built for three modes of operation: with manual gain control, with stepwise automatic gain control, or with timing automatic gain control. It includes a photomultiplier with ten dynodes, two of them and the photomultiplier anode yielding output signals through an array of emitter followers, inverters, amplitude discriminators, an emitter follower-limiter, switches and a matching circuit. It also includes a "comb" generator which produces a sequence of four pulses, and a potential-shift register which converts the "comb" to a sequence of interrogating strobe pulses. It furthermore includes the necessary integrated-circuit logic for either mode of operation. The receiver has a dynamic range of 80 dB and a passband of 25 MHz. Figures 4, references 5 Russian.
[1-2415]

UDC 535.854(088.8)

HIGH-FREQUENCY DIGITAL INFRARED PHASE METER WITH CONVERSION OF LASER EMISSION FREQUENCY

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul-Aug 81
(manuscript received 13 Jan 78, after revision 4 Feb 80) pp 203-205

FEDOSEYEV, V. A., KALENDIN, V. V., KUKHTEVICH, V. I. and SUP'YAN, V. Ya.,
All-Union Scientific Research Institute of Optico-Physical Measurements, Moscow

[Abstract] A high-precision digital phase meter has been built for measurement of constant and slowly varying phase shifts in the 9-11 μm range of laser radiation wavelengths. The instrument operates in the homodyne mode with twofold conversion of the laser emission frequency. The optical part is a modified 2-beam Mach-Zehnder interferometer with an entrance window for the radiation from a CO_2-laser. It consists of a beam splitter, two parallel mirror-lens-modulator channels (signal and reference channels), a mixer plate, another mirror, another lens, and a photoreceiver with a $Cd_xHg_{1-x}Te$ detector. The acousto-optical modulators (Ge active element and $LiNbO_3$ converter) are energized from an 80 MHz oscillator (reference channel) and an 80.050 MHz oscillator (signal channel) respectively. The phase shifting object is placed between the beam splitter and the mirror in the signal channel. Both oscillators are quartz stabilized and have automatic frequency and phase control. The photoreceiver converts the two signals coming together from the optical mixer, at frequencies ω_0+ 80 MHz and ω_0+ 80.050 MHz respectively (ω_0- optical carrier frequency of laser radiation), to one 50 kHz difference-frequency signal and sends the latter to a digital display. Here arrives also a reference signal of the same 50 kHz frequency formed by an internal mixer of electrical signals from those two high-frequency oscillators. The instrument can measure a 0-360° phase shift, with an rms error not larger than 6% when one reading is taken for 0.72 s. Figures 2, references 6 Russian.
[1-2415]

UDC 534.6

USING SCANNING ELECTRON MICROSCOPE TO STUDY PROPAGATION OF SURFACE ACOUSTIC WAVES

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul-Aug 81
(manuscript received 11 Nov 79) pp 211-212

VALATKA, R. Yu., DYUKOV, V. G., IONELYUNAS, S. A., KOLOMEYTSEV, M. I. and
PRANYAVICHYUS, L. I., Kaunas Polytechnic Institute

[Abstract] A way has been found to study the propagation of surface acoustic waves under a scanning electron microscope. The stroboscopic effect necessary for fixing the wave pattern in space is obtained through action of the ambient electromagnetic field produced by the high-frequency current supplying the converter which generates

surface acoustic waves. This electromagnetic field interacts with the slow component of the secondary-emission electron beam in synchronism with the surface acoustic waves and controls the detection of these waves by the collector of the microscope. Such an interaction is indicated by amplification or attenuation of the image contrast when the field intensity changes. A third electrode connected to the converter supply circuit and placed near the spot under investigation would amplify the image contrast appreciably, but this has been found to be unnecessary. Specimens of YZ-cut $LiNbO_3$ were examined under both the Soviet-made REM-200 microscope and the Hitachi HHS-2R microscope, the former with a conventional setup and the latter with a special collector as well as with blanking of the electronic probe for realization of the stroboscopic effect. Normal images of the substrate were obtained along with high-resolution images of the wave pattern, a feature which is necessary for nondestructive inspection of solid surface layers. Figure 1, references 4 Western.
[1-2415]

UDC 681.326.3:681.327.32

DEVICE FOR CONTROL OF LIGHT INTENSITY MODULATION

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul-Aug 81
(manuscript received 20 Mar 80) p 262

ZVEREV, B. A., ROZOV, B. S. and SAVOSTIN, P. I.

[Abstract] A device for controlling the light intensity and the exposure time is described which includes an electromechanical shutter and a light modulator as servo elements. The registers and the gates as well as the logic for determining the presence of a light beam and the decoder of control commands from a CAMAC dataway are built with series K155 integrated microcircuits. The device has been designed for manual control, automatic control, or on-line operation with a computer. The decoder produces an analog signal of maximum 7.68 V, with an output current of at least 15 mA. The maximum 7-digit code 1111111 is converted in 4 μs. The device operates from a ±6 V or ±12 V supply, drawing not more than 4 W. The entire module measures 40x240x320 mm and weighs approximately 1 kg. Figures 2.
[1-2415]

UDC 621.387.422

ELECTRODE MODULE OF STREAMER CHAMBER IN 'RISK' SPECTROMETER

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul-Aug 81
(manuscript received 21 Feb 80) pp 32-36

VERTOGRADOV, L. S., GRISHKEVICH, Ya. V., MURAV'YEV, B. A., PETER, H., PETRUKHIN, V. I., POSE, D., TOM, H., SCHWINDT, A., SHELKOV, G. A. and SPIRING, K., Joint Institute of Nuclear Research, Dubna

[Abstract] A variant of the electrode module for the streamer chamber in the RISK spectrometer has been designed in which the active space consists of two compartments in a common housing, one of them wrapped by a scintillation hodoscope for certain experiments. It operates with a bipolar 3-gap supply system, the circuit of each compartment consisting of a double stripline without a grounded center electrode. There are four electrodes: two high-voltage electrodes on the inside between two grounded (an upper and a lower) ones. All electrodes are meshes of 80 um thick stainless-steel wire with an 85% porosity each, the resultant porosity of a set of four being closer to 50%. Gaseous Freon-12 provides the anticorona insulation for the high-voltage electrodes. The latter are coupled to the high-voltage system in the streamer chamber through a flange and an adapter. The total length of the module is 600 cm, the respectively 153 and 293 cm long independently working compartments being spaced 20 cm apart. The electrostatic field in the module is uniform within 7%, only within 4% or less of the active volume does the electric field intensity differ by 1.5% or more from its nominal value. The electrodes are designed for adequate mechanical strength under the necessary longitudinal and transverse tension, with notches preventing the flow of Foucalt currents during accidental movements of the electromagnet. The streamer chamber with this electrode module operates since 1977. The authors thank E. M. Andreev, B. Yu. Baldin, O. O. Beraya (?), G. Bohm, V. N. Vlasov, Z. V. Krumshteyn, T. A. Lomtadze, R. Leiste, Y. Nemet, V. M. Suvorov and N. N. Khovanskiy for the assistance in constructing and debugging this equipment. Figures 6, references 7: 4 Russian, 3 Western.
[1-2415]

UDC 539.172.3:539.2

UNIVERSAL SPECTROMETER FOR GAMMA-RESONANCE SPECTRA OF IRON-BEARING MATERIALS

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul-Aug 81
(manuscript received 15 Jan 80) pp 29-32

KOLPAKOV, N. S. and NILOV, K. Ye., Moscow Institute of Engineering Physics

[Abstract] A spectrometer has been built for gamma-resonance spectra of iron-bearing materials. Soft gamma-radiation from a 50 mCi strong Co(Gr)^{57} source impinges on the specimen of a material. A detector with an SI-6R xenon-filled (90% Xe+ 10% C_5H_{12}) proportional counter in an aluminum case records either the radiation

transmitted or the radiation scattered by the target. The detector output pulses pass through a charge-sensitive preamplifier with a field-effect transistor in the input stage for maximum noise immunity, to an LP-4840 multichannel analyzer. This spectrometer is universal, inasmuch as the Mössbauer photons as well as the characteristic radiation can be recorded with it. Owing to the use of the SI-6R proportional counter and charge-sensitive preamplifier, with an operating voltage of 1800-2000 V, it yields an energy resolution of 1.4 keV in the energy range below 15 keV and thus performs better than the conventional YaGRS-4 spectrometer. Figures 4, table 1, references 11: 6 Russian, 5 Western.
[1-2415]

UDC 681.3

MULTICHANNEL SYSTEM WITH IONIZATION PROBE FOR MONITORING BEAMS OF ACCELERATED NUCLEI

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul-Aug 81
(manuscript received 22 Mar 79) pp 18-20

VOLKOV, V. I., KOLPAKOV, I. F., KULIKOV, I. I. and SLEPNEV, V. M., Joint Institute of Nuclear Research, Dubna

[Abstract] A multichannel system with an ionization probe has been built for monitoring high-intensity beams of accelerated light nuclei in synchrophasotron experiments. The probe tracks the ionization effect produced by such a beam in the residual gas in the vacuum chamber, this effect being proportional to the intensity of the beam. The probe consists of 24 secondary-electron multipliers and an ion-optical system, namely an accelerating electrode, an array of focusing electrodes and an array of grids. The output signals from the secondary-electron multipliers are transmitted through differential amplifiers, NIM signal shapers, and CAMAC recording equipment (24 binary counters, a digit-to-time converter, an interrupt recorder) to a Unified System YeS-1010 computer for processing. The output data appear on a graphic display panel, after having been processed for this purpose by a VT-1010 computer. The authors thank L. G. Makarov and I. N. Semenyushkin for their participation and support, S. V. Romanov for his assistance in developing and debugging the individual system components, also L. S. Russkova for her assistance in preparing the material for publication. Figures 5, references 8: 6 Russian, 2 Western.
[1-2415]

UDC 621.373.44

HIGH-CURRENT NANOSECOND ACCELERATOR FOR STUDY OF FAST PROCESSES

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul-Aug 81
(manuscript received 25 Jul 80) pp 15-18

KOVAL'CHUK, B. M., MESYATS, G. A., SEMIN, B. N. and SHPAK, V. G., Institute of High-Current Electronics, Siberian Department, USSR Academy of Sciences, Tomsk

[Abstract] A small direct-action electron accelerator with a cold cathode has been built for current pulses of a 3-50 ns duration and up to 5 kA amplitude, with an energy of electrons in the beam up to 400 keV. The vacuum diode forming the acceleration gap is connected directly to a 15-stage Marx pulse voltage generator built with ferroelectric capacitors, six capacitors in parallel with a discharger and two charging resistors in each stage. This generator is triggered from a hydrogen-filled high-voltage thyratron, synchronization within 5 ns being possible here. The output voltage of this generator can be varied from 80 to 450 kV by variation of the pressure in the discharge column, without adjustment of the discharge gaps, and a 20% voltage regulation can be obtained through adjustment of the discharge voltage. A plane graphite cathode is used for diode voltages lower than 80 kV, with small interelectrode gaps of the order of 1 mm and the generator operating at near short circuit. Such an accelerator is useful for research pertaining to fast processes in and physical properties of solids, brittle fracture and plasma luminescence of ionic crystals, also for electron-beam annealing of solid targets. With a tungsten anode, it can be used as a source of x-radiation, an IA-3 x-ray tube eliminating the need for a vacuum pump. Figures 2, references 5 Russian.
[1-2415]

FLUID MECHANICS

UDC 539.3

THEORETICAL AND EXPERIMENTAL STUDIES OF INTERACTION OF DOUBLE-LAYER ELASTIC CYLINDERS AND PRESSURE WAVE IN FLUID

Kiev PROBLEMY PROCHNOSTI in Russian No 7, Jul 81 (manuscript received 22 Sep 80) pp 14-18

LEPIKHIN, P. P., Institute of Strength Problems, UkSSR Academy of Sciences, Kiev

[Abstract] The hydroelasticity problem for a double-layer elastic cylinder was studied experimentally, a pressure wave being produced by a filament of explosive charge on the cylinder axis in a fluid. Detonations inside a special rig, including a model cylinder inside a water-filled compartment, were triggered from an outside discharge battery through electrical wiring. Measurements were made by the potentiometric method with a 10-channel instrument designed and built at the Khar'kov Institute of Aviation imeni N. Ye. Zhukovskiy (Chair of Strength of Materials) for the 20 Hz - 500 kHz frequency range, including a vibration transducer, strain gages for dynamic measurements in a resistance circuit with a parametrically stabilized voltage supply and a 10-channel amplifier (minimum gain 500), and two oscilloscopes with photographic equipment. Two cylinders were thus tested: one with the inner layer of 30KhGSA steel and the outer layer of D16T duralumin, one with the inner layer of 45 steel and the outer layer of U8A steel, each cylinder assembled with an interference fit of $(1.0-1.1)\cdot 10^{-6}$ between layers. The experimental data on propagation of shock waves in such a medium, evaluated according to available empirical formulas, were found to agree closely with theoretical calculations taking into account the nonlinearity of the fluid. An axisymmetrically propagating constant pressure pulse, accordingly, produces uniform lateral strains along an elastic cylinder. Figures 5, table 1, references 11: 10 Russian, 1 Western. [207-2415]

UDC 533.6.011

LINEAR PROBLEM OF SUPERSONIC VISCOUS GAS FLOW AROUND A VIBRATOR

Moscow PRIKLADNAYA MATEMATIKA I MEKHANIKA in Russian Vol 45, No 4, Jul-Aug 81 (manuscript received 21 Nov 80) pp 643-650

BOGDANOVA, Ye. V., Moscow

[Abstract] Supersonic flow around a thermally insulated flat plate which tapers into a triangular vibrator is analyzed in the linear approximation with respect to

the Blasius solution to the equations of the boundary layer, and with $\epsilon = N_{Re}^{-1/8}$ introduced as the small parameter. The gas is characterized by $N_{Pr} = \frac{c\mu}{k} = 1$ and $\mu_1/\mu_{1\infty} = cT/T_{\infty}$. Application of the Fourier transformation to the second-degree differential equation of the problem yields the well known Airy equation. The poles of the analytic pressure function in this equation are determined from the corresponding dispersion equation and the asymptotic behavior of its roots. The solution to the problem is then constructed in a physical plane, for harmonic vibrations of the vibrator and for vibrations with rising amplitude. The author thanks O. S. Ryzhov and Ye. D. Terent'yev for discussing the formulation of this problem and the results of its solution. Figures 4, references 5 Russian.
[3-2415]

UDC 531.35+521.1

EQUILIBRIUM SHAPES OF LIQUID BODIES LOCATED AT LIBRATION POINTS

Moscow PRIKLADNAYA MATEMATIKA I MEKHANIKA in Russian Vol 45, No 4, Jul-Aug 81
(manuscript received 22 Feb 80) pp 611-617

BARKIN, Yu. V., Moscow

[Abstract] The problem is the motion of a liquid body in the field of Newtonian attraction between two solid bodies moving in Keplerian circular orbits around their common center of mass. The two solid bodies are regarded as mathematical points with large masses, while the mass of the liquid body is assumed to be negligible with its particles interacting in accordance with Newton's second law. The equations of motion for the liquid body are derived from the Hamilton-Ostrogradskiy principle of least action, then supplemented with the equation of continuity and the Euler equations of kinematics. This closed system of integrodifferential equations admits one first integral and describes the principal three modes of motion (translatory, rotary, deforming), which are coupled. Here its particular solutions are sought which describe the motion of the liquid body as that of a perfectly solid one. Accordingly, assuming a liquid body of dimensions much smaller than its distances to both solid bodies, the constraints are determined under which its equilibrium shape will be ellipsoidal will possibly degenerate to a Roche ellipsoid at libration points in an either straight-line or triangular configuration of the three bodies. Figure 1, references 5 Russian.
[3-2415]

UDC 532.517.2

TRANSVERSE FLOW AROUND TWO CIRCULAR CYLINDERS IN TANDEM

Minsk INZHENERNO-FIZICHESKIY ZHURNAL in Russian Vol 41, No 2, Aug 81
(manuscript received 23 Jun 80) pp 310-317

BELOV, I. A. and KUDRYAVTSEV, N. A., Leningrad Institute of Mechanics

[Abstract] Transverse streamlining of two identical circular cylinders in tandem by a heat conducting incompressible fluid is considered, the distance between the cylinders being sufficiently small for the flow perturbations induced by each to interact. The velocity and the temperature of the fluid at infinity as well as the surface temperature of both cylinders are assumed to remain constant. The transient flow and heat problem is formulated in a polar system of coordinates with the origin at the centers of both cylinders, with any possible asymmetry due to the wake behind the first cylinder disregarded. The corresponding exact Navier-Stokes equations of vortex transfer in ω(vorticity), ψ(stream function) coordinates and energy equation in T (steady-state temperature of the stream) are transformed to dimensionless ones and solved, for the appropriate boundary conditions, by the method of finite differences applied to both subregions. The hydrodynamic problem is solved first, steady-state being reached when the derivative of drag with respect to time becomes approximately zero. The heat problem is solved next, steady-state being reached when the derivative of the mean (over the perimeter of a cylinder) Nusselt number with respect to time becomes approximately zero. Numerical results have been obtained for N_{Re}= 40 and N_{Pr}= 0.7, with the relative distance between cylinders varied from 2 to 20, and are compared with those for an isolated cylinder (infinitely large distance between both). Figures 4, references 9: 2 Russian, 7 Western.
[213-2415]

UDC 532.517.4

RELAXATION OF TURBULENT STRESSES

Minsk INZHENERNO-FIZICHESKIY ZHURNAL in Russian Vol 41, No 2, Aug 81
(manuscript received 16 May 80) pp 302-309

BURNOV, V. A., Moscow Institute of Machine Tools and Instruments

[Abstract] The relaxation of turbulent stresses in an incompressible fluid is calculated from the general equations of motion in the absence of external body forces. The hydrodynamic variables in these equations are split into average and fluctuation components. The volume integral here yields the resolvent equation, which is further transformed on the basis of analogy to the hyperbolic equation of heat conduction and then closed with a hypothesis analogous to the Maxwell hypothesis for viscoelastic stresses. This procedure is applied to the equation of heat balance in a turbulent stream with negligible energy dissipation and to relaxation of the thermal flux in

such a stream. It is also applied to the dispersal flow near a plane wall which suddenly starts to slide at a constant velocity and to relaxation of the frictional stress at this wall, relaxation that at some instant of time converts an initially turbulent flow to a laminar one. Table 1, references 8: 5 Russian, 3 Western.
[213-2415]

UDC 534.26

DIFFRACTION OF SOUND WAVE BY ARRAY OF RIGID CYLINDERS WITH ELASTIC CAPS

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 17, No 8, Aug 81
(manuscript received 23 Apr 79) pp 107-110

VOVK, I. V., Kiev

[Abstract] Diffraction of sound waves by a plane periodic array is considered, the array consisting of short rigid cylinders with thin elastic caps at both ends. In the case of normally incident sound waves this problem is, by virtue of symmetry, equivalent to diffraction of a plane wave by a single cylinder inside an infinitely long regular hexagonal waveguide with acoustically rigid walls. The problem can be further reduced to that of a circular waveguide with the same cross-sectional area. The corresponding differential equations, including the Helmholtz equations and the equations of vibrations for circular plates, are solved for the appropriate boundary conditions with hinge coupling between cylinder and end caps. The solution is obtained after the acoustic field has first been subdivided into three different characteristic regions. The solution yields the frequency dependence of the transmission coefficient and reveals a wide resonant peak at low frequencies. The results are useful for the design of a most effective sound proofing. The author thanks V. T. Grinchenko for discussing the results and L. A. Kononuchenko for assisting with the calculations. Figures 4, references 6: 5 Russian, 1 Western.
[2-2415]

UDC 536.711.66.045.7

COOLING EFFECT IN WAVE-GENERATING ADIABATIC EXPANSION OF A GAS

Moscow IZVESTIYA AKADEMII NAUK SSSR: ENERGETIKA I TRANSPORT in Russian No 2, Mar-Apr 81 (manuscript received 8 May 80) pp 139-142

ARKHAROV, A. M., BONDARENKO, V. L., DESYATOV, A. T. and PRON'KO, V. G., Moscow

[Abstract] A device called a wave converter is used to create a pressure loss in order to convert the energy of an expanding gas into the energy of elastic vibrations, whereby it is possible to transport this wave energy beyond the limits of the system and to come close to a reversible process of expansion. The wave energy

can be radiated directly into the environment or the energy of the vibrations can be converted directly into heat or electric energy, and these forms of energy can be removed beyond the limits of the system. The results are given of experiments for investigating this phenomenon and the cooling effect observed in the wave-generating adiabatic expansion of a gas. The cooling effect was studied by using two separate pieces of apparatus. The first was a pin-type gas-jet wave generator developed by Hartmann (1922) combined with a parabolic reflector with ports for releasing the expanding gas and a heat-insulated chamber with a tube for the gas outlet. The design of this apparatus makes it possible to separate the flows of radiated wave energy and of the expanding spent gas. The other apparatus utilizes a Hartmann-Sprenger tube as a resonator. When the supersonic stream of gas flowing into the tube is slowed down auto-oscillations of the column of gas in the cavity of the tube are generated. When the oscillating gas column interacts with a solid heat-conducting wall at the closed end of the tube the intense absorption of the energy of the oscillations takes place resulting in considerable heating of the wall. The end of the tube was heated to 1050 to 1100 K in the experiments conducted, utilizing helium. Thus, the energy of the wave process is converted into heat, which can be removed from the apparatus. The experiments demonstrated that the wave-generating adiabatic expansion of gases in apparatus of the gas-jet generator type is accompanied by a cooling effect, that the amount to which the temperature is lowered depends on the properties of the gas, and that the process described here is thermodynamically more effect than the throttling process. The wave-generating adiabatic expansion process can be realized in equipment which does not have moving parts and is thus of interest for cryogenics. Figures 3, references 6: 4 Russian, 2 Western.
[198-8831]

MECHANICS OF SOLIDS

UDC 629.7.024.14

EXPERIMENTAL STUDY OF SANDWICH SHELL STABILITY IN TRANSVERSE FLEXURE

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian No 6, Jun 81 (manuscript received 14 Dec 79) pp 21-22

MANANDYAN, L. T., candidate of technical sciences, assistant (instructor)

[Abstract] For the first time an experimental study was made pertaining to the stability of cylindrical sandwich shells in transverse flexure. Five specimens of various lengths were tested, their two load carrying layers made of steel with a layer of FK-20 foam plastic between them bonded to both with BF-88 adhesive. The tests were performed in a 50-ton dynamometer machine, with a shell mounted horizontally at one end and loaded by a vertical force at the free other end. The buckling mode was found to depend on the length-to-radius ratio. The loss of stability in long shells ($L/R \geq 5$) was similar to that under uniform compression, but with the swelling concentrated near the clamped end. The loss of stability in short shells ($L/R \leq 3$) was determined principally by the shearing stresses, with the swelling pattern similar to that under torsion. Approximate expressions for the critical load are derived on the basis of these experimental data, yielding values 20% lower than theoretical. The experimental data are characterized by a small variance. Figures 2, table 1, references 2 Russian.
[206-2415]

UDC 536.12:539.377

SOLUTION OF THERMOMECHANICAL PROBLEM FOR TUBULAR STRUCTURAL ELEMENTS

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian No 6, Jun 81(manuscript received 16 Oct 79) pp 7-11

POSTOL'NIK, Yu. S., candidate of physico-mathematical sciences, docent

[Abstract] A thick and long hollow cylinder clamped at both ends is considered as a model of tubular structural elements in petrochemical and thermal power plants. Its two-dimensional state of strain and three-dimensional state of stress which axisymmetric nonuniform heating produces in such a cylinder are determined according to the quasi-static theory of thermoelasticity with a generalized Hooke's law, both the modulus of elasticity and the coefficient of linear thermal expansion of the

material being temperature dependent and, therefore, nonuniformly distributed. An approximate analytical solution to the resolvent differential equation of the problem is obtained by the method of equivalent sources. On this basis, for a steel (Kh18N9T) pipe heated on the outside surface by a constant source, the maximum tensile stress at the inside surface is calculated as a function of the ratio of inside to outside radii. The numerical results are found to agree closely with those obtained by the method of perturbations and by the method of the Moscow Power Engineering Institute. Table 1, references 8 Russian.
[206-2415]

UDC 539.3:534.1

INTEGRALS OF EQUATIONS OF VIBRATIONS FOR ROTATING SHELLS OF REVOLUTION

Leningrad VESTNIK LENINGRADSKOGO UNIVERSITETA: MATEMATIKA, MEKHANIKA, ASTRONOMIYA in Russian No 13, Issue 3, Jul 81 (manuscript received 13 Nov 80) pp 114-117

SMIRNOV, A. L.

[Abstract] Integration of the equations of vibrations for shells of revolution rotating at a constant angular velocity about the axis of symmetry is shown, with the Coriolis acceleration and the axisymmetric initial stresses due to centrifugal forces accounted for by additional terms in the classical theory. The fundamental equations in dimensionless form are reduced to a system of eighth-order ordinary differential equations with a small parameter as the coefficient at the highest-order derivative and these are solved by the method of asymptotic expansions. The specific cases considered are axisymmetric vibrations with a small number of waves around the parallel, describable by a single eighth-order equation, nonaxisymmetric low-frequency vibrations, and axisymmetric high-frequency vibrations. The asymptotic expansions of the integrals have different structures, depending on the relations between the parameters of the equations. Reference 1 Russian.
[211-2415]

UDC 539.3

CALCULATING GEOMETRICALLY NONLINEAR VIBRATIONS OF SPHERICAL SHELLS UNDER IMPACT LOAD ACCORDING TO STRAIN THEORY OF ELASTICITY

Leningrad VESTNIK LENINGRADSKOGO UNIVERSITETA: MATEMATIKA, MEKHANIKA, ASTRONOMIYA in Russian No 13, Issue 3, Jul 81 (manuscript received 27 Nov 80) pp 70-75

BERMUS, I. M., SRUBSHCHIK, L. S., STOLYAR, A. M., FOMIN, V. L. and TSIBULIN, V. G.

[Abstract] The equations of axisymmetric motion of a shallow spherical shell under a uniformly distributed transverse pressure pulse are formulated on the basis of the Kirchhoff-Love hypotheses and solved according to the strain theory of plasticity

for an incompressible material with linear hardening. General relations are derived for the resultant forces and moments, assuming a plane state of stress and strain, which cover the three possible states of each shell element during the process: elastic state, state of active plastic loading, and state of unloading. The shell deflections are calculated according to the algorithm of the explicit "cross" scheme in the method of finite differences with subsequent numerical integration by the Simpson method, after a meridional cross section of the shell has been subdivided into N segments along the radius and L segments across the thickness. The algorithm has been written in ALGOL-GDR and programmed on a BESM-6 high-speed computer. Numerical results are given for a rigidly clamped circular plate and for a spherical shell under rectangular or sinusoidal pressure pulses. Figures 3, references 7 Russian.
[211-2415]

UDC 539.3

CYLINDRICAL SHELL UNDER DYNAMIC LATERAL LOAD

Moscow PRIKLADNAYA MATEMATIKA I MEKHANIKA in Russian Vol 45, No 4, Jul-Aug 81 (manuscript received 5 Jun 78) pp 766-768

SOKOLOV, F. A., Moscow

[Abstract] An elastic circular cylindrical shell of uniform wall thickness is considered in a plane state of strain under a pressure load which varies in time. The two-dimensional equations of motion in radial and tangential displacements are solved for a pressure load with circumferential distribution in the form of an infinite Fourier series of cosine waves and a constant component. After Laplace transformation with respect to the time variable, assuming zero initial displacements, application of the convolution theorem yields the solution for displacements in the form a constant component and infinite Fourier series of sine and cosine space harmonics varying periodically in time: each as a difference of two sine components at its own two different frequencies and the constant (in space) component at the base frequency only. References 2 Russian.
[3-2415]

UDC 531.38

QUALITATIVE ANALYSIS OF TWO-DIMENSIONAL AND NEARLY TWO-DIMENSIONAL MOTION OF SOLID BODY AROUND STATIONARY POINT

Moscow PRIKLADNAYA MATEMATIKA I MEKHANIKA in Russian Vol 45, No 4, Jul-Aug 81
(manuscript received 8 May 80) pp 618-623

YAKH'YA, Kh. M., Egypt

[Abstract] Two-dimensional motion of a solid body is defined as its motion with a variable angular velocity around one of its principal axes of inertia, one which remains in a fixed horizontal position. Here such a motion of a solid body around a stationary point is considered in a conservative force field. The corresponding system of equations, which admits an area integral, has been reduced to a single differential equation in elliptical x,y coordinates and the latter is now transformed to the $\frac{d^2y}{du^2} + p(u)y = 0$ equation, where $p(u) = \frac{1}{2}F^0_{yy}(x(u))$ and F is the force function. On the basis of this equation the author analyzes the orbital stability of the trajectory of a point mapped onto the (x,y) plane at a fixed value of the Jacobi constant. The procedure is then applied to solid bodies with two equal principal moments of inertia in a Newtonian (uniform) gravitational field, where they rotate when the Jacobi constant is large and librate when the Jacobi constant is small. It is also applied, together with the Zhukovskiy criterion, to a dynamically asymmetric body with three unequal principal moments of inertia. In this case the solutions are found to correspond to periodic variation of the Euler angles and, generally, to quasi-periodic motion relative to the precession angle and thus quasi-plane motion when the body is very different from a dynamically symmetric body. The author thanks V. G. Demin for his assistance in this study. Figure 1, references 7: 5 Russian, 2 Western.
[3-2415]

UDC 539.3:534.1

SOLUTION TO AXISYMMETRIC PROBLEM OF DYNAMICS FOR ANISOTROPIC SHORT THICK-WALLED CYLINDER

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 17, No 8, Aug 81
(manuscript received 17 Jan 79) pp 95-100

SENITSKIY, Yu. E., Kuybyshev Institute of Structural Engineering

[Abstract] A closed solution to the axisymmetric problem of dynamics is obtained for a hollow orthotropic cylinder constrained radially at the bases but free to move axially, with arbitrary boundary conditions at the lateral surfaces. For specificity, the inside surface is under a normal load and a tangential load, both varying arbitrarily lengthwise and in time, while the outside surface is fit into a rigid yoke. The two-dimensional equations of motion, together with the initial and

boundary conditions, are written in cylindrical coordinates and solved by the method of finite integral transformations in matrix form. The problem reduces to fourth-order differential equation with variable coefficients. The algorithm of the solution has been programmed for a BESM-4M high-speed computer. Here typical results are shown for a solid cylinder 0.3 m long made of a fiberglass-plastic material with either five times more reinforcement in planes perpendicular to the axis then along the generatrix or vice versa. Figures 2, references 5 Russian.
[2-2415]

UDC 539.3:534.1

FLEXURAL HIGH-FREQUENCY VIBRATIONS OF CIRCULAR PLATE

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 17, No 8, Aug 81
(manuscript received 26 Mar 80) pp 62-68

KOMISSAROVA, G. L., Institute of Mechanics, UkSSR Academy of Sciences, Kiev

[Abstract] Axisymmetric flexural vibrations of a free isotropic circular plate are considered, of particular interest being the frequency range which corresponds to two propagating modes. The reference frequency $\Omega = 1$ is taken as the frequency at which one of these two modes becomes locked, which is also the fundamental frequency of shear vibrations across the thickness. An analysis of the dispersion equation and its roots reveals a satisfactory agreement between the Timoshenko shear theory and the exact solution according to the classical theory of elasticity below the reference frequency $\Omega < 1$ as well as above it within the $1.1 \leq \Omega \leq 3$ range, i.e., until the third propagating mode appears. Figures 6, references 11: 7 Russian, 4 Western.
[2-2415]

UDC 539.3

DESIGN OF BOXLIKE SHELL WITH RECTANGULAR CROSS SECTION

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 17, No 8, Aug 81
(manuscript received 5 May 80) pp 48-55

TIKHOMIROV, V. V., Leningrad Polytechnic Institute

[Abstract] A semiinfinite shell of a uniform rectangular cross section is considered which consists of four plates joined along their lateral edges. Homogeneous orthogonal solutions to the equations of equilibrium are obtained for such a shell. The problem is solved for tension, the procedure being analogous for torsion and flexure. The state of stress and strain is calculated and dimensionless numerical values of deflections and moments are shown for such a box-shell made of a material with $\nu = 0.25$ Poisson ratio. Figure 1, table 1, references 7 Russian.
[2-2415]

UDC 539.374

ELASTOPLASTIC STRESSED STATE OF CONICAL SHELL OF REVOLUTION DUE TO NONAXISYMMETRIC HEATING

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 17, No 8, Aug 81
(manuscript received 18 Mar 80) pp 42-47

MERZLYAKOV, V. A., Institute of Mechanics, UkSSR Academy of Sciences, Kiev

[Abstract] The thermoelastoplastic state of stress of a closed truncated conical shell under nonaxisymmetric force and heat loads is analyzed on the basis of the Kirchhoff-Love hypothesis, with the mechanical properties of the shell material assumed to be temperature dependent. The differential equations describing the physical relations are derived from the theory of small strains, with Hooke's law extended to include thermal and irreversible strains, and are then linearized according to the method of elastic-strain solutions. The calculations have been programmed in ALGOL-60 for a BESM-6 high-speed computer. Here numerical results are shown for such a shell made of EI-395 steel with a Poisson ratio $\nu = 0.3$, on hinge supports at the bases and in a natural unstressed state at temperature $T = 0$, and with a $T = (323 + 25\cos\theta)$ K temperature distribution around the circumference. The results reveal regions of compressive and tensile stresses along the lateral surface and of shearing stresses near the bases. For comparison, results are also shown which correspond to an axisymmetric temperature field with $T = 323$ K and $T = 348$ K. Figure 1, tables 4, references 4 Russian.
[2-2415]

UDC 539.3

APPROXIMATE EQUATIONS OF AXISYMMETRIC VIBRATIONS FOR CYLINDRICAL SHELLS

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 17, No 8, Aug 81
(manuscript received 15 May 78) pp 25-30

ANDRIANOV, I. V., Dnepropetrovsk Institute of Structural Engineering, MANEVICH, L. I., Institute of Chemical Physics, USSR Academy of Sciences, Moscow

[Abstract] An orthotropic circular cylindrical shell is considered and the general equations of its axisymmetric free vibrations are written in projections on the axes of an undeformable system of coordinates. Affine transformations of coordinates and representation of the sought functions in the form of series in a small parameter yield, in the first approximation, equations which describe the limiting case of nonlinear vibrations of a flexible beam. Application of constant axial forces at the ends linearizes the original problem, the first approximation still revealing the nonlinear effects. The nonlinear effects are also revealed by the first approximation for a shell rigidly clamped at the ends, without axial displacements, or for a shell with hinge supports at the ends. However, the system of approximate equations is consistent only in the quasi-linear (small amplitude) case. For nonlinear

plane vibrations of a circular ring (shell of infinite length), moreover, the nonlinear effects can be revealed by higher-order approximations only. References 6 Russian.
[2-2415]

UDC 533.6:013.42

TRANSIENT INTERACTION OF PLATES AND SHELLS WITH CONTINUOUS MEDIA (REVIEW)

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian No 4, Jul-Aug 81 (manuscript received 25 Nov 80) pp 177-189

GORSHKOV, A. G., Moscow

[Abstract] This is a review of latest research on transient interaction of thin structures and their elements (plates, shells) with an ambient medium: gaseous (air), liquid (water), or solid (ground). It covers three areas only: action and effect of shock waves on deformable thin structures, impact of thin structures on deformable barriers with subsequent penetration, transients in engineering and consumer equipment and structures due to natural periodic phenomena such as quakes, winds, and tides. It summarizes the theoretical studies of important problems in these areas, the methods of analysis and calculation, and in a special section the experimental studies in these areas--all based on material published during the 1976-80 period. References 119: 95 Russian, 24 Western.
[4-2415]

UDC 539.371.629.7.024

DESIGN OF IRREGULAR REINFORCED THIN-WALLED SHELLS CHARACTERIZING HELICOPTER FUSELAGE FOR NATURAL VIBRATIONS BY FINITE-ELEMENT FORCE METHOD

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian No 4, Jul-Aug 81 (manuscript received 10 Apr 80) pp 149-159

BAYAZITOV, F. F. and BURMAN, Z. I., Kazan'

[Abstract] A helicopter fuselage is regarded as an irregular reinforced thin-walled shell and its natural vibrations are calculated as those of a free body consisting of finite elements. The three equations according to the method of forces are reduced to a single vector equation and the latter is put in matrix form according to the method of displacements, with the singularity of the stiffness matrix (arising from the use of the known Green's influence function for a body rigidly fixed at its center of gravity) removed. A procedure for reducing the order of an unwieldy dynamic matrix is shown which yields accurate results, as demonstrated on four experimental cantilever shells and an actual helicopter fuselage (456 finite elements,

53 concentrated masses with two degrees of freedom, 4 concentrated masses with three degrees of freedom, 5 external masses, dynamic matrix of the 118th order). The results of computer calculations according to the beam theory agree closely with test results pertaining to the first four modes. Figures 3, references 12: 5 Russian, 7 Western.
[4-2415]

UDC 539.3:534.1

NONAXISYMMETRIC FREE WAVES IN CYLINDRICAL SANDWICH SHELLS

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian No 4, Jul-Aug 81(manuscript received 21 Mar 79) pp 140-148

POZHUYEV, V. I., Zaporozh'ye

[Abstract] Propagation of nonaxisymmetric free waves in a cylindrical sandwich shell is analyzed, such a shell consisting of an inner sheath and an outer sheath with a filler between them. The equations of motion for the two load carrying sheaths take into account the normal reaction of the filler, both sheaths assumed to have the same thickness. The motion of the filler is described by the three-dimensional vector equation of dynamics in the theory of elasticity. The entire system of equations for all three layers is solved, assuming propagation of sine and cosine waves, to determine the load transmitted from the sheaths to the filler. Then the wave equations are obtained, with the aid of potential functions, whereupon displacements and stresses are calculated in accordance with Hooke's law. The problem reduces to a system of homogeneous algebraic equations for the coefficients in the solution to the wave equations and the condition of nontriviality here yields the dispersion equation. A perfectly rigid inner sheath and a hollow filler (no inner sheath) are considered as special cases. An approximate solution to the general problem is shown for a cylindrical sandwich shell with a compressible isotropic rigid filler. Numerical results, including the phase velocity as a function of the wave number, have been obtained with the aid of a Unified System YeS-1022 computer. Figures 4, references 10: 7 Russian, 3 Western.
[4-2415]

UDC 539.374

CHANGE IN DIRECTION OF MOTION OF SOLID BODY ON INTERFACE

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian No 4, Jul-Aug 81 (manuscript received 14 Sep 79) pp 105-109

RIVIN, Yu. K., Moscow

[Abstract] An experimental study was made of the motion by inertia of solid bodies obliquely crossing the boundary between two media without bouncing, specifically of a steel ball and a steel cone striking a plane surface of plasticine from air. Refraction of the rectilinear trajectory was found to occur, with a short curvilinear transition at the boundary. Analysis of the results reveals that the refractive index $k = \sin\theta_i/\sin\theta_r$ does not depend on the incidence angle but depends on the impact velocity $k = (v_i - v_0)/v_i$ (v_0 is a constant with the dimension of velocity). Accordingly, there also exists a critical angle which separates incidence with penetration from incidence with bouncing. This angle decreases with decreasing impact velocity, which explains the multiple bouncing of a hard solid from a soft surface. With an impact velocity of 300 m/s, the test data for a steel ball and plasticine have yielded a critical angle of 77.5°. With the same impact velocity at an incidence angle of 70°, the test data yield $v_0 = 9$ m/s. Impact at velocities below 9 m/s results in bouncing after an indentation. Impact at velocities above 20 m/s results in penetration without bouncing. Figures 6, references 3 Russian.
[4-2415]

UDC 539.374

CHANGE IN METEORITE TRAJECTORY UPON SURFACE IMPACT

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian No 4, Jul-Aug 81 (manuscript received 14 Sep 79) pp 99-104

KOLESNIKOV, V. A., Moscow

[Abstract] Oblique entry of a rigid sphere into the lower half-space is treated as a one-dimensional collision problem in a stationary system of Cartesian coordinates. The interaction of this body and the medium of the half-space during impact and penetration are analyzed on the basis of the momentum theorem and assuming the properties of the half-space medium to be close to those of terrestrial ground, with many experimental data available. The "refraction" of the body's trajectory at the surface in the process of impact and deformation is determined from stress calculations. The refractive index, expressed as a function of the deflection angle, has been found to depend only on the incidence angle and the bulk compression. Shearing stresses have a negligible effect. As the velocity at impact increases, moreover, the refractive index should approach unity. The author thanks N. V. Zvolinskiy, Yu. K. Rivin and L. M. Flitman for their interest and helpful discussions. Figures 4, references 9: 8 Russian, 1 Western.
[4-2415]

UDC 534.13

ROTATING SHAFT STABILITY

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian No 3, May-Jun 81 (manuscript received 22 Dec 80) pp 157-161

ZHBANOV, Yu. K., Moscow

[Abstract] It has been concluded in an earlier study (A. A. Kel'zon: DOKLADY AKADEMII NAUK SSSR Vol 248, No 2, 1979, pp 310-313) that the rotation of a stiff shaft in two elastic bearings is unstable when the center of mass of the shaft lies on the axis of rotation. Here this conclusion is shown to be wrong. With the centering forces of the bearings independent of the shaft rotation and with the motion of the center of mass described in a rotating system of coordinates, there does indeed appear an instability due to an arbitrarily small eccentricity which cannot be removed by dissipative forces, unless they stall the shaft, but this instability is completely unrelated to the system as stipulated in the original problem. The instability there appeared following an erroneous extension of the equality of two angular velocities (one relative to the shaft axis and one relative to the axis of rotation), valid in the steady state, also to any transient state. Here the presence of a small eccentricity has no effect on the character of the steady-state motion. Figures 5, references 6 Russian.
[215-2415]

UDC 539.3:534.1

ANALYSIS OF TRANSIENT PROCESSES IN SHELL STRUCTURES BY SCHEME WITH MINIMUM VARIANCE

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian No 3, May-Jun 81 (manuscript received 19 Jul 79) pp 66-73

MALYSHEV, A. P., Moscow

[Abstract] A grid scheme of direct calculations is proposed for analyzing the transient response of shell structures to pulse loads, a response which involves interaction of perturbation waves propagating with reflections at free surfaces and other inhomogeneities. Parabolic interpolation in the corresponding Cauchy boundary-value problem minimizes the variance of the finite-difference solution relative to the exact solution and thus reduces spurious oscillations, although it does not increase the order of accuracy beyond the second. A stable solution by this scheme is obtained, for instance, for shells of revolution with shear and inertia. The convergence of such a solution is demonstrated here on the model problems of a semiinfinite cylindrical shell to which a Heaviside step velocity has been imparted at the base and a multiply-connected shell structure with k kinematic constraints and 1/2m- k static constraints (k junctions and m unknown parameters at boundary nodes in an intermediate grid layer). Figures 7, references 15: 11 Russian, 4 Western.
[215-2415]

UDC 539.3

ONE-DIMENSIONAL CONTACT PROBLEMS IN SHELL THEORY

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian No 3, May-Jun 81 (manuscript received 26 Nov 79) pp 55-65

ARTYUKHIN, Yu. P., Kazan'

[Abstract] An exact solution of one-dimensional contact problems in the theory of thin-walled shell is shown which takes into account transverse deformation. The condition of contact, namely the equality of deflections of the bodies in contact, yields an integral equation which, together with the appropriate influence functions obtained by superposition of those in any application theory, leads to a Fredholm integral equation of the second kind. The hypothesis of an undeformable normal would yield a solution to a mathematically incorrect problem and a solution in the form of a Neumann series converges only for a small contact area. Reduction to a boundary-value problem for the corresponding differential equation, utilizing the commutative property of the differential operator and the filtration property of the delta function, yields a solution in explicit form valid for any size of the contact area. This method yields simple expressions for the contact stresses in such typical cases as an infinitely long cylindrical shell shrunk into a rigid sleeve with an interference fit and flattening of a cylindrical shell by compression around an arc of the circumference with two punches. The author thanks S. V. Mitin for performing the calculations. Figures 4, references 27: 24 Russian, 3 Western. [215-7415]

UDC 621.031.539.334

ANALYSIS OF NONLINEAR DEFORMATION OF CYLINDRICAL SHELLS UNDER NONAXISYMMETRIC LOAD BY FINITE ELEMENT METHOD

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian No 3, May-Jun 81 (manuscript received 26 Mar 79) pp 49-54

ZHELEZNOV, L. P. and KABANOV, V. V., Novosibirsk

[Abstract] The problem of nonlinear deformation of a cylindrical shell under a nonaxisymmetric load is solved by the finite element method with the shell subdivided into n cylindrical segments. Axial and circumferential displacements as well as deflections of points are represented as sums of products of polynomials by trigonometric functions, with the unknown coefficients of these polynomials expressed through amplitudes of nodal displacements in the corresponding harmonics. The potential energy, equal to the difference between the potential deformation energy and the work done by the external load, yields the vector of forces and the stiffness matrix for each harmonic in accordance with static and kinematic relations. These and the vector of displacement amplitudes enter into the equation of equilibrium for each harmonic, the summation here over all finite elements yielding the system of

algebraic equations for the shell. This system is solved by iterations, with the load first stipulated as a small one and then gradually increased to its ultimate level. In the process the linear algebraic equations are solved by Cholesky decomposition and the nonlinear terms are carried from preceding steps. The algorithm has been programmed with standard routines on a BESM-6 high-speed computer for calculating the nonlinear deformation of shells with various constraints and under various loads. It is demonstrated here on a circular cylindrical shells on free supports and under an axial compression force which varies stepwise around the circumference. Figures 6, references 2 Russian.
[215-2415]

UDC 531.7:681.3.004.14

HEADS FOR AUTOMATIC COORDINATE MEASURING MACHINES

Moscow IZMERITEL'NAYA TEKHNIKA in Russian No 8, Aug 81 pp 24-25

KASPARAYTIS, A. Yu. and PERFILOV, V. V.

[Abstract] Heads are the critical components of automatic coordinate measuring machines, inasmuch as they directly interact with the surface of a part and thus determine the accuracy of the entire system. Most industrial measurements with heads are made by the point method, which does not require precise positioning for high accuracy and thus also ensures an efficient operation, electric signals being generated upon contact and processed by a computer. All heads designed for various applications consist of one or several feeler pins with tips in a holding and moving fixture, a sensor responding to displacements of the feelers while the tips make contact with the measured surface, and an electrical system which includes signal generating transducer coils and a voltage supply. Conventionally a flange mechanism is used for holding and moving the feeler set, the flange being centered through three rollers or balls 120° apart on prisms formed by roller or ball pairs. The design is a tradeoff between efficacy of small size on the one hand and equalization of forces and displacements on the other. An improved version of such a head has been developed which eliminates all obvious factors detrimentally affecting the performance. The flange mechanism is built up, it includes an intricate system of disks, springs, diaphragms and stop screws for centering and guiding the feeler set, and it also carries the coils of an inductive transducer wound on an iron core. The main sources of error in this as well as other internal-action heads are the sliding friction between surfaces in contact moving relative to one another at low velocities through small displacements, and the inevitable residual inequality of forces within the flange mechanism, the error reaching 2 μm regardless of the size of the measured object. A higher accuracy is attainable with external-action heads, where the command signal is generated without displacement of the feeler set and the measuring force is smaller. Figures 2, references 5: 3 Russian, 2 Western.
[209-2415]

UDC 621.9-229.002.56:681.7

DEVICE BASED ON LINEAR VIDEO-SIGNAL SHAPER FOR NON-CONTACT MEASUREMENT OF DIMENSIONS OF PARTS

Moscow IZMERITEL'NAYA TEKHNIKA in Russian No 6, Jun 81 pp 20-22

SKRIBANOV, Ye. V., BRATENKOV, A. A., GRISHIN, M. P. and NIKONOV, A. S.

[Abstract] An optoelectronic device has been developed for non-contact measurement of the dimensions of parts which is based on geometrical coding of data. The disadvantages of large error due to surface roughness in direct amplitude measurements, of low stability and narrow linearity range in pulse-time measurements with electromechanical scanning, and of structural complexity in the combination of both these conventional methods have been eliminated in the new device. It consists of an image converter with an A-1034 linear video-signal shaper containing 1024 light-sensitive resolution cells and a digital processor. The object surface is illuminated from a lamp through a slit diaphragm and a projection objective lens so that a light dash forms on the surface. Light reflected from here passes through a receiver objective and forms an image of the dash on the converter surface. The converter output signals are processed digitally by amplitude quantization in a video amplifier with a constant quantization threshold. The centers of pulses are tracked in the device, which should theoretically reduce the error of readings to zero. Actually, however, the usual 50-100 μm error corresponding to surface roughnesses from R_z40 to R_z0.1 is reduced to ±0.01 mm, this being an instrument error due to instability of the light intensity and the supply voltage as well as other disturbing factors. The linearity range is 4 mm, one reading is obtained in 0.1 s. The width of a light-sensitive cell is 15 μm which, with an optical reduction factor K= 3, yields a discreteness of 5 μm. Figures 2, references 3 Russian.
[210-2415]

UDC 621.039.66

ASK-3 AUTOMATED SPECTROMETER COMPLEX FOR PLASMA DIAGNOSIS

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul-Aug 81
(manuscript received 11 Apr 80) pp 264-265

CHUBRIK, N. I., SHIMANOVICH, V. D., YERSHOV-PAVLOV, Ye. A., KRAVCHENKO, A. Ye. and SPITSYN, I. G.

[Abstract] The ASK-3 spectrometer complex has been built and automated for diagnosis of an electric-arc plasma as well as plasma jets and any homogeneous or nonhomogeneous plasma object. It includes a programmable 2-channel SM-2 spectrometer (200-1200 nm range of wavelengths with a resolving power up to 25,000) with a monochromator (passband 0.02-0.7 nm), space scanning (200 steps/s) and spectrum scanning (1000 steps/s), a photocounter and a keypunch with interfacing, a small computer (15VSM-5 or D3-28), a control module, and a "Consul 254" typewriter for transcription and tabulation of output data. The spectrometer tunes automatically to preset spectral bands in minimum steps of 0.02 nm. Up to 4096 readings can be recorded. The complex operates from a 220 V - 50 Hz line, drawing 440 VA. It measures 1200x700x450 mm and weighs 140 kg. Figure 1.
[1-2415]

UDC 543.05.08:536.421.1

DEVICE FOR AUTOMATIC DETERMINATION OF MELTING POINT OF CRYSTALLINE SUBSTANCES

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul-Aug 81
(manuscript received 18 Feb 80) pp 246-249

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[Abstract] "Kristall-2" extends the development of devices for the determination of the melting point of crystalline substances. The phase transition is indicated by a change in the luminous flux passing through a specimen. The device consists of a fan-cooled metal crucible surrounded by a bifilar heater coil under a layer of thermal insulation, with two windows for a light beam to pass through. A small specimen is placed inside in the path of the light beam, which comes in from a lamp guided by a light conductor and leaves the crucible along another light conductor leading it to a photoresistor. Inside the crucible is also placed a platinum temperature probe 6 mm in diameter and 80 mm long. Linearity of readings within ±0.1°C is ensured by a temperature transducer producing 10 mV/°C signals and automatically switching ranges every 100°C. The signals are transmitted to a digital voltmeter, through a transcriber to a printer, and through a temperature regulator and an analog processor to a recording instrument. The analog processor also receives signals from the photoresistor and it controls the cooling fan. Changes in the output voltage of the photoresistor indicate respectively the beginning and the end of the "softening" process, while the amount of solid substance remaining in the path of the light beam decreases continuously during the melting period. Accordingly, the analog processor includes a differentiator followed by matching stages and threshold circuits (Schmitt triggers). There are a buffer stage and a matching amplifier at the input to the differentiator. Two diodes, one across and one behind the differentiator, ensure an adequate interference immunity of the analog processor. The temperature regulator is set to the temperature within a ±10°C range about which the given substance may melt. In the case of fast heating data processing and recording does not begin until the temperature inside the crucible has reached the lower boundary of this range. The author thanks N. N. Smolkov for his assistance in preparing and performing the laboratory tests of this equipment. Figures 4, references 2: 1 Russian, 1 Western.
[1-2415]

UDC 621.373.826:621.317

NANOSECOND PYROELECTRIC DETECTOR OF INFRARED RADIATION

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 4, Jul-Aug 81
(manuscript received 10 Dec 79) pp 205-207

KULESHOV, V. P. and MALYUTA, D. D.

[Abstract] A pyroelectric detector for recording the power of radiation pulses from a CO_2-laser has been built which features the necessary response characteristics. It consists of a 5x3x1.5 mm $LiNbO_3$ crystal with an intrinsic capacitance of 2 pF and two fringe electrodes of a silver-based conductive adhesive deposited on it. The time constant of this detector does not exceed 0.1 ns so that, when its load is a long cable matching it to an oscilloscope with a 50 Ω impedance and a 500 MHz bandwidth, the risetime of a detector signal will be approximately 0.7 ns and correspond to the risetime of a radiation pulse at the laser amplifier output. This detector is not sensitive to ultrasonic vibrations in the crystal, as is a detector with frontal $LiTaO_3$ electrodes, nor does it have the inertia with an attendant long pulse falltime characteristic of a detector with ceramic fringe electrodes. Figures 3, references 6: 5 Russian, 1 Western.
[1-2415]

UDC 620.179.152.5.05

DVS-2 GAMMA-RAY FLAW DETECTOR FOR TESTING WELDS IN HULL STRUCTURES

Leningrad SUDOSTROYENIYE in Russian No 5, May 81 pp 36-37

PEDANOV, F. F.

[Abstract] A description is given of the DVS-2 small-scale gamma-ray flaw detector developed at the Leningrad Shipyard imeni A. A. Zhdanov and introduced into production. This instrument has a reliable biological shield of depleted uranium and a lightweight high-strength titanium alloy used for its remaining parts makes it possible for a single person to carry the flaw detector easily to the test site along with the stand provided for setting it in its working position. A thulium-170 source source of "soft" gamma radiation makes it possible to make a radiographic inspection of lightweight alloys. The conical collimated beam of gamma radiation has an angle at its apex of 53°. Steel up to 60 mm thick can be inspected with an Ir-192 source and lightweight alloys up to 40 mm thick with a Tm-170 source. The power of the exposure dose of gamma radiation at a distance of 1 m from the surface of the radiation head in the storage position is not greater than $21.6 \cdot 10^{-11}$ A/kg. The flaw detector with its handle measures 132 x 350 mm and the working unit weighs 8.7 kg, the radiation head 3.6 kg and the stand 1.5 kg. The flaw detector consists of a case into which is inserted a radiation head in the form of a hollow cylinder inside of which is placed a biological shield having an axial cylindrical channel ending in

a tapered bore for the purpose of collimating the radiation. At the bottom of the case there is another shield of depleted uranium enclosed in a titanium shell for the purpose of providing a biological shield when transporting the flaw detector. A cartridge whose end has a seat for the radiation source is inserted into the cylinder's shield unit and a tungsten alloy plug covers the source in the cartridge's channel and provides a biological shield in the axial direction. A cap screws onto the cylinder from outside to make it airtight. The cylinder is removed from the flaw detector's case with a hinged handle with a crossbar. The cylinder's handle can be turned 90° for convenience in setting up the cylinder when working under constrained conditions. Charging and recharging with a radioactive source are simple and are accomplished by means of a special tipper device. The stand is fastened to the hull's framing and up and down the stand's stanchion can be moved a crossbar at whose end there is a ring for installing the flaw detector's radiation head (the cylinder). This device makes it possible to radiographically inspect welds in any position in space. The entire preliminary installation of the stand and its centering at the point of inspection are carried out without a radiation source, thus reducing the probability of the operator's being exposed to radiation. The saving from introducing a single flaw detector of this sort has equaled 5000 rubles per year. Figures 3.
[204-8831]

UDC 621.3.048.1.81:621.313.12.001.2

'ELASTONIT,' NEW INSULATION SYSTEM

Moscow IZVESTIYA AKADEMII NAUK SSSR: ENERGETIKA I TRANSPORT in Russian No 2, Mar-Apr 81 (manuscript received 23 Jun 80) pp 150-155

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[Abstract] A summary is given of experience gained in creating a new system of insulation with improved properties. The role of mica as a barrier in high-voltage insulation is discussed, along with the substrate as the basis for producing insulating tape and new binders for insulating tape. A description and the results are given of studies on new insulating tapes of the "Elastonit" type based on the use of Mylar films, Fluorolon epoxy binders and a new type of mica barrier. Scanning electron microscope studies were conducted with magnifications of 550, 2200 and 11,000 on sections of tape. The regular distribution of mica particles observed ensures good density and solidity. Large inclusions more than one micron thick are not present. The dielectric strength of test specimens was not reduced below 50 MV/m in aging tests at 200 and 160° C in 10 cycles. The change in volume resistivity of "Elastonit" insulation when aged at 200°C for 20 cycles was slight and was maintained at a level of 10^{14} Ω·cm and was not lowered below 10^{13} Ω·cm after wetting. Tests demonstrated that the mean service life of "Elastonit" insulation under a field strength of 10 kV/mm at a temperature of 20°C is on the order of 4000 h. "Elastonit" insulation exhibits good resistance to the simultaneous influence of an electric field and vibration, which is attributed to the structure of the mica barrier. Comparative tables are presented of the key characteristics

of several kinds of electrical insulation tape and high-voltage chassis insulation. The improved technological properties evidenced by "Elastonit" when used as chassis insulation are due to the use of Fluorolon epoxy binders in combination with film materials. Figures 2, references 2 Russian.
[198-8831]

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